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Science Education

FEBRUARY, 1937

THE AIMS OF SCIENCE TEACHING*

EDWIN G. CONKLIN

President, American Association for the Advancement of Science

After I had decided to speak to you on the "Aims of Science Teaching" I found that the simile suggested by the word "aims" could be carried further. Our aims in teaching are too often like those of the amateur hunter or soldier who shoots into air and at things in general. In war it is said that only one shot in a million counts and about that proportion seems to hold in hitting rabbits or students. The gun used is usually an heirloom handed down to us from some former teacher or pedagogical hierarchy and whether popgun, blunderbuss or cannon is used on all occasions irrespective of the game and aim. The ammunition is usually in the form of standardized cartridges loaded with wad from textbooks or old lecture notes. The man behind the gun is the teacher and he usually gets more kick out of the shooting than the man in front of the gun who is the student or victim. Too often the teacher is interested only in scoring a few hits and the student in getting passed.

As a result of more than fifty years of teaching in many grades from the one-room, ungraded country school to the graduate work of the university, I am impressed with the thought that our methods of teaching generally lose sight of the chief aim or purpose of all instruction. This is true of all teaching, whether in the sciences or the humanities. The ancient conflict between science and the classics was a dispute about guns and ammunition rather than about the more important matter of aim and objective, and to this day the pedagogical hierarchy and the teachers' training schools are concerned more with pedagogical guns and ammunition than with the man behind the gun or the all important aim.

If I were to write my "confessions" I should repent the fact that in my teaching I have frequently thought more of my subject than of my subjects, more of information than of education. Of course we all strive to impart knowledge of the subject which we teach but we are too often satisfied if our students are able on examination to give back to us in more or less mutilated form the information which we have conveyed to them. Information has its place in education but its chief value is to serve as a means to more important ends.

All education is a phase of development, and all conscious education is an attempt to draw out or develop certain inherited capacities. During the whole of my career as a scientist I have been a student of animal development, and I have observed that in all forms of development, whether it be that of an animal or plant or of the body, mind and morals of a human being the same fundamental factors are involved. Heredity fixes the capacities of every creature whether plant, or animal or man; environment, which includes training or use, brings these

* Address at Luncheon Meeting of Science Teachers' Association, Atlantic City, December 31, 1936.

capacities to full development. The inherited potentialities or capacities of any creature are much greater than are ever realized in development. In attempting to control development we seek to stimulate certain capacities and to suppress others. The experimental embryologist can begin his experiments with the earliest stages of development. By various physical and chemical stimuli he can cause an egg to give rise to twins or multiple embryos, he can produce many forms of abnormal or monstrous individuals.

After the birth of the embryo the experimental zoologist can greatly influence the later development by modifications of food, temperature, and functional activity. Anything and everything that can possibly develop under any possible set of conditions was inherent in the egg from which the animal came. By modifying the environment one or another of these capacities may be inhibited and others developed.

The true teacher is also a student of development. It is true that the material on which he works comes to him much later in life than in the case of the experimental embryologist, but the fundamental principles are essentially the same at all stages in the life cycle, and in the development of mind and character as well as of the body.

The inherited capacities of every human being are vastly greater than those that come to development. In each one of us there were several alternative personalities, which we might have been but only one of which we actually are. By our environment and training as well as by our heredity we are what we are. There is good biology in the old saying attributed to John Wesley, as well as several other religious leaders, who on seeing a drunken sot exclaimed, "There but for the grace of God goes John Wesley." As intellectual and social characteristics develop later than the physical ones they are more subject to experimental control.

The teacher therefore is a worker in the field of experimental development. Whether he knows it or not he is attempting to develop certain capacities of his students and to repress others. The methods used may vary enormously but they may all be classified as stimulations and inhibitions, or more strictly as stimulations only, for inhibitions are stimulations of an antagonistic sort. A muscle stimulated contracts, a gland secretes, a nerve conducts, an egg develops; without stimulation nothing happens, which is saying nothing more than that every thing has its cause or causes, whether in the world of lifeless or of living things. Such causes may be external or internal and what we call automatic action merely means that the immediate cause is internal. A self-starter in man is no more causeless than a self-starter in an automobile.

Stimulation then is always necessary to call forth any response, whether it be of an organ or an organism. My students have sometimes mutilated this statement by saying that "stimulants" are necessary for any action, but the word "stimulant" has almost as many meanings as the word "spirit." In the development of the mind no less than of the body stimulation is necessary and the good teacher is the one who knows how and when to apply the proper stimulus. Unfortunately for mass education, individuals differ so greatly that ideal stimulation must be individually applied, but fortunately all normal human beings have so much in common that in groups selected as to capacity and stage of development certain forms of stimulation may call forth corresponding responses in all.

Another fundamental biological principle is that when responses to stimuli are frequently repeated they become more easy, more rapid, more nearly automatic, more like reflexes. These are known as "conditioned reflexes" or habits, and they are the most valuable and lasting results of all education. Indeed I think it doubtful whether there is any other permanent result of education. Information may last until examination but not much longer. Alumni do not recall the lessons they so laboriously

learned and upon the remembrance of which they passed or failed in their examinations, but they do remember the habits they acquired, often from casual contacts with teachers or students. And how frequently they recall the unconscious behavior, the careless words of a teacher. When my old students tell me of some of these things, which have entered into their permanent mental furniture and become a part of their habits and character, I think of the saying of Scripture—"For every idle word and act ye shall be brought into judgment." The imparting of information which is the chief aim of most teachers is the least permanent and important of their functions. "Whether there be tongues they shall cease, whether there be knowledge it shall vanish away, but now abideth character."

The essence of all real education is habit formation. Heredity is first nature, habit is second nature. Heredity is unalterably fixed from the moment of the fertilization of the egg, habits are conditioned reflexes and are acquired. The true aim of all great teaching is to guide students to the acquirement of good habits and the avoidance of bad ones. This applies to habits of body, mind and morals, and within the limits of inherited capacity, habits determine whether one is a worker or an idler, reliable or unreliable, helpful or selfish, a success or a failure.

The true measure of education is not information, not examinations, but habits and character,—and I wish we had some better methods of measuring this than those now in use in our schools. It is true that examinations themselves if they are well conducted teach habits of concentration, accuracy, order, construction, initiative and independence, but as usually given they are in the main mere memory tests. Here as in class instruction the teacher should realize that the chief aim of teaching is not knowledge but character and that all good teaching begins with inspiration or stimulus, proceeds to illumination or example, and that mere information is the least important of the three; information, illumination, inspiration and the greatest of these is inspiration.

All this is true of teaching in general, but what should be the principal aims in science teaching? The study of science is peculiarly well suited to develop habits of curiosity, accuracy, logical and rational deductions, distinction of fact from fancy, reliance on natural causation rather than magic, appreciation of the fact that all knowledge is the result of experience and that it is never perfect but is always capable of improvement, humility in realizing

> "How little we have gained
> How vast the unattained,"

aesthetic appreciation of the stability, order and beauty of nature, ethical devotion to truth, sympathy and service. Here is a program to stimulate the enthusiasm of every science teacher. How sadly the world needs such habits is evident on every side. The world is full of people whose education has crushed or dwarfed these habits, people who are unable to distinguish reason from emotion, truth from propaganda, evidence from ballyhoo; people who think that their opinions are absolutely right and that all who differ from them are absolutely wrong; people who are unable to criticize their own views, to acknowledge unwelcome truth, to see that all knowledge is relative, to "conceive it possible that they may be mistaken"; people who are unable to see that all behavior, even irrational behavior, has natural and therefore understandable causes, and that the only way to cure or alleviate disorders, whether physical, mental or social, is to remove or control their causes; people who are unable to put themselves, in thought and sympathy, in the places of others from whom they differ and to appreciate the partial truth of the saying, "To comprehend all is to pardon all."

The peace and progress of mankind depend upon the acquisition of such mental

and moral habits as make for peace and progress. The social disorders of our present world are not so much due to heredity, or original sin, or the devil, as to the bad social habits that have been inculcated. The usual teaching of science has not prevented the formation of such anti-social habits but it is none the less true that science teaching is peculiarly well fitted to cultivate sound mental and social habits. This, in my opinion, should be the chief aim of science teaching.

SOME IMPORTANT CONSIDERATIONS IN THE EDUCATION OF SCIENCE TEACHERS*

JOHN C. JOHNSON
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This Conference on the Education of Teachers in Science came into being in a very natural way. First, a few men and women, interested in the better training of prospective science teachers, got together very informally for some two years. Others joined them. As they thought and worked together, the problems to be solved increased rapidly in number, much faster than the problems that were solved. This called for a stronger organization and more determined effort on the part of a larger number, so our present organization was formally chartered two years ago this month at West Chester.

Since there are so many problems ahead to be solved, and probably always will be, the job seems almost hopeless, yet the fact that the trail is dim and untrod means that our opportunity is correspondingly great.

Now that I shall likely be surrendering the president's chair, with which you have honored me for two years, I want to point out a few, just a few, of the important problems ahead, as I see them, of this important organization. I said important organization because I think there are extremely few similar organizations in the United States larger than a single state unit. In a sense then, we must function as a national organization, at least until such a time as there is one comprising all the states.

It is probably correct to say that no group in America now has the almost universal respect that the men of science have, in spite of the many fakers who have posed as scientists, of those who falsely quote scientists, and of those who prognosticate almost as ancient soothsayers in the name of science. Since there is such general respect for science, and its work, in spite of these, it is quite obvious that the teachers of science, and especially those who train prospective teachers of science, have an unusually heavy responsibility.

This responsibility will probably be even greater in the future, since more and more, throughout the United States, regular classwork in science is being extended down into the elementary grades. It has become evident to many leaders of scientific and educational thought, that the facts and principles of science, together with the method of the scientific approach to most problems, are too important and fundamental to be delayed until the senior high school. By that time many have dropped out of school, and for those that remain, their habits of thinking are largely fixed and can be changed only at too great a cost.

In almost every important field of endeavor, science is playing a more fundamental rôle, decade by decade. Is this not true in economics, government, sociology, education, and psychology, the arts, and even religion? I was going to say even in politics, but politics, it seems, has degenerated almost completely into the art of deception. In fact, it is doubtful if much progress can be made in any field of en-

* Address by the President, Conference on Education of Teachers in Science, Montclair, New Jersey, November 6, 1936.

deavor without using the scientific approach to the problems involved, and the facts and principles of science that have already been worked out.

If you agree with the thesis that just as engineering schools should accept the chief responsibility for training engineers, medical schools for physicians, dental schools for dentists, and law schools for lawyers, so should the Teachers College, and Schools of Education in our larger universities, accept the major responsibility for training most of the teachers for our schools, which of course include the junior and senior high schools. If you accept this thesis, which is already accepted in most parts of the United States, then it immediately becomes the bound duty of the Teachers College and Schools of Education to greatly raise their standards, and to train the finest possible kind of teachers; and this certainly holds true for prospective teachers of science.

It should be kept in mind constantly, that in our area at least, very few institutions have seriously tried to formulate a curriculum primarily to train science teachers. If some fine teachers have come from the liberal arts college and the university (and some have) they have come almost entirely in spite of the curriculum, not because of it. Survival in spite of, not because of, is true in many fields of endeavor. It is high time now, and the opportunity is truly thrilling, to be allowed to participate in the planning and training of the science teachers for the future.

But before we, as Teachers Colleges and Schools of Education, can win this major opportunity of training the majority of the fine science teachers for our schools, we must win the confidence of the principals and superintendents, and other influential men and women in our area—and confidence can be won only by a carefully planned curriculum by careful conservative, yet progressive leaders, who have had actual experience in addition to theoretical experience.

The first major problem ahead, of course, is to have in mind what a science teacher needs, indeed, must have, if he is to become a fine teacher. We must see our problem as a whole first, then break it up into its important units.

It seems obvious to me, and I so recommend to this conference, that we see to it that our general plans for prospective science teachers include the following: (1) the professional, (2) the academic, and (3) the research viewpoints. Perhaps I should say each prospective teacher should have (1) a professional major, (2) an academic major with a minor or two, and (3) in addition, some slight acquaintance at least with the methods of research.

Even though I had my entire undergraduate training in a State Teachers College (Colorado), where methods were stressed at the expense of academic scholarship, yet it seems to me now that if something must be sacrificed, it had better not be the academic. One cannot substitute even fine methods and techniques for basic facts and principles. Fortunately, neither the professional nor the academic need be sacrificed if the curriculum is planned wisely, nor does some slight experience with research need to be excluded.

The greatest criticism ever hurled at the old two-year Normal School and the new four-year Teachers College (at least in its earlier years, in all of the areas of the U. S.) is that their graduates "don't know anything." Happily this is no longer true with some of the older Teachers Colleges and is becoming less true with most Teachers Colleges year by year. Therefore, it seems, we had better "fall over backwards," if necessary, putting real meat into our science courses at the present time, rather than spending too much time on our methods and techniques, and devising new ways of combining the sciences into new integrated courses. Let us take the various sciences now taught in our Teachers Colleges and universities, and point them in the direction of teacher training rather than

scrap these courses and set up new ones integrated in character. In other words, to be specific, let us continue to give a solid course in General College Chemistry (and other advanced courses in chemistry) keeping in mind that the students in the class will become teachers, not commercial chemists, rather than making combined (mixed) courses in Chemistry, Zoology, Physics, Botany, Geology, and Astronomy. It will be a long time, if ever, before the general public and the superintendents and principals will scrap their high-school courses in Chemistry, Physics, and Biology in favor of integrated courses. If we want our graduates in science from our Teachers Colleges to secure jobs, we had better have them well-grounded academically in one or two fields rather than be "jack-of-all trades" in many fields. The surest way to kill ourselves at the start is to train people for jobs that do not exist, and are not likely to exist in high schools to any great extent.

This does not mean that I am satisfied with the courses that now exist in our Teachers Colleges, with the sequence of courses, with the way they are given, or with their content. Certainly we do not want to stop experimentation on the part of some of the leading thinkers in Science in such fine places as Teachers College, Columbia University and New York University. But we must not all try to be experimental stations, even though we need a few. Let us encourage a few instructors, or institutions, to experiment for a period of about two student generations (about 8 years) before we ask the majority of institutions to adopt a course of training that seems doubtful to many to start with. After all, whether a course or a curriculum "works" is far more significant than whether it sounds as though it will work—just good theory.

Let us work with the liberal arts colleges and universities, not against them. If we keep our science courses pointed (professionalized) toward the training of teachers, but with solid meat in them, we can win the respect and win out and thus eventually receive the opportunity of training the major portion of science teachers.

We ought to take a leaf out of Nature's book of change—namely, the steady gradual change, rather than the mutant way, which is rarely successful. We want evolution, rather than revolution. The latter destroys too much with too little corresponding gain.

So in planning our science curricula, especially for the secondary science teachers, I hope we will see to it that there is as much meat and as much laboratory work in our courses as is to be found in similar courses taken in our liberal arts colleges and universities. If we do not, we deserve to perish.

I further recommend along this line that we make as a major project for the next few years the work now being started by the Committee on Minimum Essentials for the Training of Science Teachers in Higher Institutions. I also urge that each of you select some part of the work of this committee. You will receive a hearty welcome by the chairman, Professor E. R. Glenn, of Montclair. Perhaps this is our real major problem for some time to come.

Another recommendation is that we on the faculties of our Teachers Colleges raise our own standard of scholarship, both academic and professional. Certainly we should have at least the equivalent in training of those in the liberal arts colleges and universities. Should anyone be intrusted with the major responsibility of training prospective science teachers, who has not had actual teaching experience in science courses in the junior or senior high school, several years of practical experience in some college or university, and the equivalent of a doctor's degree? We dare not set lower standards for ourselves than are required in other institutions of collegiate rank. In no other way can we win respect of the thinking public and especially of school administrators, that we so badly need. We should quit fooling ourselves in

thinking that any one of us knows enough to teach all the sciences of college grade. Does anyone here honestly know of anyone who can do so? Certainly I don't. It is far better to have adequately trained instructors, with fine rich backgrounds, give the various science courses, provided they keep in mind they are teaching prospective science teachers, rather than the inadequately trained generalist with a necessarily poorer background. After all, the students must be allowed to think for themselves—they must in the final analysis, do the integrating of the facts and principles gleaned from the various sciences.

Another important problem ahead of us is to devise means for the selection of students to become prospective science teachers. Who should be encouraged to go ahead, with their scientific training and who advised to drop out? Surely some fairly accurate means, tests, and otherwise, can be worked out. The person, or persons, who will do that will be solving one of the greatest needs at the present time.

Still another important problem that we must keep constantly in mind for our prospective high-school teachers of science, is that they will likely want to study for a higher degree in the great graduate schools of the country. We must see to it that they are not handicapped when they start—that they do not have to take in the undergraduate college undergraduate courses while they are graduate students. To my certain knowledge and to the utter disgust of many graduates of Teachers Colleges they have to do this very thing. Within the last ten days, one fine graduate of one of our Teachers Colleges, majoring in science in this area, received a letter from the Dean of the Graduate School of one of great universities saying: "We do not accept graduates of any Teachers Colleges directly into the graduate school. They must enroll in the university for one semester and then apply for admission." Should we not make such a situation impossible shortly? There is only one way to do it.

Finally, I beg of this organization, let's make haste slowly. Let's not scrap the well-tied experiences of the older Teachers Colleges in the various parts of this country. Let's remember that the science men now teaching in our various colleges and universities have been trained in one or two sciences rather well, rather than widely and poorly trained in all of the sciences. Whatever we do, we must be humane, we must not scrap them, the men, for a theory. Let us use these men of science who have a rich deep background in some particular field of science. Of course we want to change, gradually in the right direction, but not too fast. Of course we want to experiment, cautiously and draw conclusions carefully. Few will deny that, especially for our experimental schools in our great universities, but while we elevate our heads and hopes into the air of the future let us also keep our feet on the ground of whatever experiences we have or can find.

THE MORRISON UNIT IN BIOLOGY

THOMAS F. MORRISON
Milton Academy

Within the past two or three years interest in the so-called "unit plan," or "Morrison plan," has shown a marked increase. Ever since 1926, when Morrison[1] first advocated the method of teaching subjects by "learning units," there has been an increasing amount of literature published on the subject, and if one were to take this as the sole criterion of its popularity, one might easily imagine that it was being widely accepted in all fields of pedagogy. Although there is no quantitative data at hand, reports lead one to believe that its acceptance by

[1] Morrison, H. C. *The Practice of Teaching in the Secondary School.* Chicago, Ill.: University of Chicago Press, 1926 (revised 1931).

teachers of biology is not as wide-spread as some of its proponents would have us believe. Furthermore, it is clearly evident that while the "learning unit" might be well adapted for certain subject-matter courses, yet it may not be as well suited for other branches. It does not follow, therefore, that a method such as this will find equal value in all fields.

Morrison has divided all of the subjects which are taught at secondary-school level into five types among which is the science type, and the methods which he proposes for the teaching of other types are more or less influenced by the method employed in this type of subject. Whether the actual steps advocated by Morrison are adhered to in their proper sequence in all of the schools which profess to follow this plan is not within the scope of this discussion. A very excellent review of the progress made with this plan is given by Billett.[2] Suffice it to say, that, regardless of how closely the exact theoretical steps are followed, the fundamental idea of teaching a subject by placing the emphasis on the principle rather than on the isolated fact serves as the basis for all of these courses.

The development of a subject as outlined in Morrison's plan may be considered theoretically to be one of the best methods devised thus far for presenting the contents to the students. That it has its serious limitations has been pointed out recently by Bayles,[3] and it is the intention of the present writer to discuss briefly some further limitations of this method when it is applied to the teaching of biology. It should be reiterated that the unit plan is felt to be valuable as a means of presenting the broad aspects of a subject, but from the practical standpoint difficulties which it develops appear to almost offset the advantages which accrue from its use.

Biology is a subject which deals with life and living organisms, and in the biological laboratory the teacher is constantly confronted with the problem of arousing and holding a student's interest in one phase of the subject at a time. It is the experience of nearly every teacher that his students are interested in all of the phenomena connected with the particular animal or plant which they are studying and not simply with a single aspect of the organism's life or environment, and it is in connection with this diversity of interests that one of the first difficulties arises.

Let us suppose that the class is attempting to answer the question, "How do animals get their food?" Let us suppose, furthermore, that this is one of the introductory topics of the year and the one in which students are introduced to such forms as the paramecium, the hydra, and the crayfish. It has been the experience of the writer and of some other teachers with whom he has discussed this method of teaching, that it is only with great difficulty that the students' attention is centered on the problems of food-getting when they see for the first time the other activities of the animals they are studying. If a description of the animal in its entirety is taken up at this time, then too much time is devoted to materials which will be covered again at a later period; if, on the other hand, the natural curiosity of the students is ignored, then on later occasions these same forms still present many unsolved difficulties, but the difficulties are not as eagerly solved as they would be in the first enthusiastic contact. But if there is a detailed study of the animals made at the time when the class is introduced to them, then the Morrison plan loses its force and is simply another interpretation of the older method of acquiring uncorrelated, factual knowledge.

In the two other branches of Natural Science most frequently taught in the secondary schools, namely, physics and chemistry, there is relatively little difficulty encountered in handling or keeping laboratory materials. Neither the physicist nor

[2] Billett, R. O. *Provisions for Individual Differences, Marking, and Promotion.* Monograph No. 13, National Survey of Education. Washington, D. C.: Government Printing Office, 1933.

[3] Bayles, E. E. "Limitations of the Morrison Unit." *Science Education* 18: 203–207; December, 1934.

the chemist need fear the spontaneous development of the material on his shelves to a point which renders it useless, or the disappearance of demonstration and laboratory materials if a modicum of care is used. The biologist, on the other hand, must be on guard constantly against the contamination of his cultures, the growth of plants and animals beyond a point where they will be of use to him in a specific experiment, and the death of the very animals which he had hoped to use. This problem of the maintenance and care of living things in a biological laboratory is of much greater difficulty than the uninitiated are inclined to believe. Laboratory conditions, at best, are artificial living quarters for most organisms which under such conditions are apt to fall prey to factors having little effect on them in their natural environment. It takes an especially gifted and trained teacher to maintain an adequate supply of living material throughout the year in his laboratory, and too many of the secondary school teachers have duties thrust upon them which cut into the amount of time which they can devote to this exacting type of work. It may be argued that modern visual aids could be used to replace a large amount of this living material. If that is done, biology ceases to fulfil the definition of the subject as a "study of life."

The connection of this to the unit plan is obvious when one realizes that the problem of food-getting with which we started the year is followed by a study of, let us say, respiration, and this in turn by circulation, irritability, and the other fundamental vital processes. In each case it is necessary to have the same material on hand to illustrate these principles. There are relatively few schools so fortunately situated that they can employ an assistant who can take care of the animals and plants, or can turn to the nearest supply house for fresh material.

Under the old plan of teaching biology when work on a group of animals or plants was once completed, there was not the necessity of maintaining that vivarium or aquarium throughout the remainder of the year. Under the Morrison plan this abandonment of materials is impossible. Add to this the fact that several phases of the work call for growing plants at definite stages in their life-cycles, and the difficulties of the biology teacher are increased, especially when these plants may be required at the same stage on several different occasions during the course of the year.

A third difficulty which has presented itself to teachers is the result of the naturally reoccurring cycles in nature. One of the principal phases of biology is the relation of the theoretical side of the study to the practical problems confronting plants and animals. This is usually considered under the topic of Natural History, and this aspect of biology should play a large part in the post-school life of the child, especially in the satisfactory utilization of the leisure promised by our modern social order. The more conventional method of the development of the subject was admirably suited to the seasonal changes since it was possible to correlate closely the field work with the class work. With adherence to the unit plan, such a correlation is difficult. If the topical method is followed, a field trip in the fall of the year is apt to be barren of lasting results because the students do not have the background of factual knowledge on which they can draw in answering the many "whys" which arise, and the data must be filed away until some future date when they can understand the fundamentals of living processes.

In illustration of this point, the writer has in mind a field problem on plants. The laboratory directions which had been furnished by the authors of the text directed the students to study some particular plant growing in the natural condition and discover how it was able to survive in the face of the many difficulties with which it was beset. The shape of the plant, its relations to the surrounding plants, its protective mechanisms were all carefully outlined for the student and he was expected to answer

some very leading questions and draw some interesting conclusions. If the problem of protection against the encroaching neighbors was all that the plant had to meet, then this field trip would have been highly successful, but there are other problems of equally vital importance which the plant must face, and these could not be discussed because the student did not have the background upon which he could draw for information.

Finally, there is the amount of factual knowledge which is placed at the disposal of the students. The interpretation placed on the Morrison plan by many of the modern text-book writers has led to an underemphasis of the number of facts required for the student to master a principle. One of the great criticisms of many secondary-school texts in the past has been the inordinate amount of factual material which the student was required to assimilate. It is a hopeful sign that this phase of the subject is being discounted, but it is necessary to keep in mind the relation of the factual material of these principles. In one very popular text which the writer has reviewed quite thoroughly, the authors omit a discussion of the anatomical structure of the brain, yet discuss the relation of the central nervous system to various physiological activities. It is obvious that the students do not find this satisfactory for it does not give them something concrete upon which they can base their later work. College texts can afford to follow such a plan because they serve a purpose other than that demanded of texts in secondary schools. The general tendency in the more recent texts has been to spread the subject matter in a very thin layer over the principles, expecting the student, or the teacher, to make the necessary inferences and additions during the course of the study.

It is of considerable moment that the method used in presenting a subject be well-adapted to the materials of the subject. If, however, there are difficulties of a fundamental nature encountered, the demand for a definite procedure may work disadvantageously, and in the end the subject may become the victim of the method.

SURVEY COURSES IN THE NATURAL SCIENCES

CLARENCE M. PRUITT

Science courses as a part of the curriculum of American colleges antedate the founding of this republic. In those early days of relatively limited knowledge of the material universe, the more or less artificial boundary lines of modern science were not recognized. The course in natural philosophy included much material from other science fields not now commonly included in college physics courses. To a limited extent many of those earlier science courses were the forerunners of present-day survey courses. Indeed a great many so-called survey courses of today are duplicating these earlier courses, albeit they are enhanced with the accumulative effects of man's inventive genius and discoveries.

As man's knowledge of the material universe increased, specific fields in science have become more and more delimited in scope and the number of science divisions has correspondingly increased. Not only has the number of separate divisions of science greatly increased, but the increases in the number of courses offered within each of these divisions is many fold greater. In the earlier days the instructor could attain a fairly comprehensive knowledge of all the fields of science and, in addition, a specialist's knowledge of his own field. The student likewise could attain a fair degree of comprehension of the scientific knowledge of that day, inasmuch as it was possible for him to hear lectures in all the science offerings and still retain time for the other curriculum offerings. Differentiation has paralleled the increase in the knowledge of the universe until at the present time

eight or ten distinct science departments may be found within one college or university, with many instructors in each division. Many of these instructors are specialists in one specific phase of that division. Thus it has come about that it has not only long been impossible for a trained scientist to have a comprehensive knowledge of the sciences outside his own special field, but this is becoming practically true within his own division. Many college science teachers are specialists, each cultivating his own little plot of ground in the world of ideas.

Accompanying this narrow specialization of the trained scientist (very desirable and necessary for specific purposes) there has developed the practice in many colleges of requiring the non-science majors to take a year's work in one of the specialized divisions of the sciences, *e.g.*, geology or physics. Consequently the student has no opportunity for acquaintance with other equally important phases of his environment. Thus students have come to think habitually of science as being divided by a series of vertical lines, each with its distinctive name, its own particular material, and its distinctive principles and problems. Students consequently get the notion that the world of ideas in science is made up of isolated fragments. Thus it has been difficult, if not impossible, for the undergraduate to secure a modicum of information from each of the fields of science and as impossible to correlate and integrate the information he has obtained.

As society has evolved, the curriculum offerings have been greatly expanded to meet the needs of a complex machine civilization. The appropriateness of a course in a specialized science, as a part of general education, to meet the needs of those not specializing in science has recently been questioned, especially in the last decade. Administrators, recognizing that science is the most influential factor in the action and thought of the modern world, are introducing a generalized science course into the curriculum. This course has been variously designated as a *survey* course, an *orientation* course, a *general science* course, and an *introductory science* course. It is possibly true that a few individuals make some distinction between survey and orientation courses. But for all practical purposes the two terms are synonymous both as to purposes and as to content. Powers[1] quotes Havighurst as describing two types of survey courses appropriately designated as *comprehensive* and *selective*.

"In order of emergence the comprehensive courses come first. Subject matter of the comprehensive courses is chosen from the major divisions of science and arranged so that the student may 'survey' these divisions. A typical survey of physical sciences 'is designed to orient freshmen in the fields of astronomy, chemistry, geology, and physics. Through introduction to these sciences it aims to give a concrete conception of the physical world, some knowledge of scientific method and the part it has had in the intellectual life of the race, and the contributions of the physical sciences to the solution of contemporary problems.' Another, broader in its scope, is 'a course to teach the fundamental laws of physics, chemistry, and biology; to present, by practical demonstration, laboratory techniques; and to lead students into the field of scientific thought through library research.' "

Increasing emphasis on human activities and human relations has favored the development of the second type of course. In these *selective* courses, areas of human interest and activity are used as criteria in the selection of content for instruction. These areas may include: (1) Human growth and development; (2) maintaining personal and public health; (3) recreational activities; (4) economic-industrial life, including (a) production, control, and consumption of energy, (b) production and consumption of food, (c) production and consumption of materials (metals, alloys, ceramics, etc.);

[1] Powers, S. R. "What Educational Needs Have Favored the Development of Survey Courses in the Natural Sciences." *The American Physics Teacher* 3: 191–192; December, 1935.

and (5) thinking about life and the universe, including (a) aspects of man's scientific world-model, structure, and evolution of the physical universe, evolution of life, factors that relate to and condition human thinking and action, etc. and (b) relations of science to other fields of knowledge. This newer type of course surveys these areas of human interest. Selective courses may be less comprehensive. Some are limited to a particular theme from pure science, such as evolution or energy, following it through the various areas of science in which it appears; in such courses the theme is chosen because of its interest and importance in human affairs. These selective courses may be contrasted with the comprehensive type for in them no effort is made to give a 'comprehensive' survey of science fields. Content is *selected* for particular purposes and criteria such as are suggested by the foregoing definition of areas are used for guidance in making selections.

The terms *analytical* and *descriptive,* also used by Havighurst, are useful in describing both types of survey courses. In my opinion (which seems to be in agreement with Havighurst's) the terms *analytical* and *descriptive* are subheadings under comprehensive and selective. Thus, courses may be described as comprehensive and analytical, comprehensive and descriptive, selective and analytical, or selective and descriptive."

Bossard says that the first orientation course in American colleges was offered in 1915–16. Havighurst reports that a study of the curricula of 300 colleges of ten years ago indicate that five were giving survey courses in science. A similar study made last year indicates that out of approximately 1,400 universities, colleges, teachers colleges, junior colleges, and colleges for negroes, about 150 were offering survey courses in science and that about one-third of those offering courses were teachers colleges. It seems also to be true that the per cent of publicly supported institutions offering survey courses greatly exceeds the per cent of privately supported institutions offering such courses. Certainly the trend is toward a great increase in the number of institutions offering survey courses.

Different institutions have attempted to meet the demands for a broadened curriculum in various ways. Several institutions, such as Butler University, the University of Maine and others, offer a general orientation course for freshmen which includes some science. The University of Washington offers a survey course in each of the special sciences, *e.g.,* survey of astronomy, survey of geology, survey of botany, with laboratory work being an integral part of each course. In the University of Florida plan, six comprehensive courses are required of each student during the first two years of the general college. Two of the six courses are: "Man and the Physical World" and "Man and the Biological World." However, these two courses are not quite in the nature of survey courses. There is a syllabus for each course and each of the sixteen sections has a member of the science faculty who meets with it three times a week for a whole year.

The University of Chicago was among the first institutions to offer a survey course in science. This course was entitled "The Nature of the World and of Man" and consisted of lectures and demonstrations by members of each division of the pure sciences. Since that time the course has been considerably modified as to content and method. A syllabus has been prepared in each division of the survey course (Biological Sciences and Physical Sciences). A list of indispensable readings and optional readings are included in the syllabus. This Chicago course has probably exerted a greater influence on survey courses than that of any other institution.

Colgate University has put into operation a series of four survey courses required of freshmen. Two of the four survey courses are in science—one in biological science and the other in physical science. No attempt is made to survey the entire domain of the natural sciences. The

students are placed in sections. In the physical sciences there are nine sections of eighteen to twenty students each, with seven instructors. One instructor takes one or two sections throughout the entire course "in order to avoid confusion caused by the student having to meet several instructors during one course—particularly important to a freshman who is just getting adjusted to college, and it helps instructors to know students personally."

Columbia College of Columbia University has more recently instituted a two-year survey course—one semester in each of the following science fields: astronomy and geology; physics; biology; and chemistry.

While teachers colleges and liberal arts colleges have the greater number of science survey courses, two excellent courses have been developed in the School of Commerce, Finance and Accounts of New York University and in the Wharton School of Finance and Commerce of the University of Pennsylvania. Each school has developed a fairly comprehensive syllabus, and the Wharton School instructors have written a textbook to accompany the course.

In order to obtain certain information relating to survey courses the author sent out a questionnaire to 128 teachers colleges and liberal arts colleges. Replies were received from 111 schools. Thirty-five of the liberal arts colleges replying do not offer survey courses whereas twenty-three do so. Twenty state teachers colleges do not offer survey courses and thirty-three offer such courses. The ratios here indicated are probably not those actually existing as no attempt was made to make certain a random sampling. They are fairly well distributed sectionally among the better schools of the United States.

The accompanying table summarizes the replies from those schools offering survey courses.

There is an almost unanimous practice of offering the survey course (it is so

REPLIES FROM TWENTY-THREE LIBERAL ARTS COLLEGES AND THIRTY-THREE TEACHERS COLLEGES

	Liberal Arts	*Teachers Colleges*
1. Is the course elective for freshmen?	No 12 Yes 11	No 25 Yes 7
2. Is the course required for freshmen?	No 11 Yes 12	No 7 Yes 25
2. Is the course elective for upper classmen?	No 9 Yes 10	No 22 Yes 10
4. Are non-science majors required to take additional science courses?	No 17 Yes 2	No 22 Yes 5
5. Does the course count as a part of the major or minor for those majoring or minoring in science?	No 16 Yes 4	No 17 Yes 12
6. Do the same teachers teach both the biological and physical science phases?	No 14 Yes 7	No 28 Yes 4
7. How many hours credit does the college give?	Range 3 to 12 semester hours. Mean 8 semester hours.	Range 3 to 10 semester hours. Mean slightly over 7 semester hours.
8. Do you have individual student laboratory work in connection with the course?	No 18 Yes 2	No 28 Yes 4
9. Do you use your own syllabus?	No 6 Yes 15	No 14 Yes 16
10. Do you use a text book in the course?	No 13 Yes 7	No 23 Yes 8

named in many colleges) in the freshmen year and preceding all science courses. Only H. A. Webb of George Peabody College for Teachers indicates any inclination to question the present practices. Professor Webb says, "There has been considerable discussion among us as to whether a survey course should come early or late in the student's college career. If early, it serves for orientation, but there is little foundation on the student's part. If late, it serves as a sort of a résumé and broadening of interpretative powers, but students have specialized to such a degree that, as a rule, they do not really want it. It is difficult to make the advantages and disadvantages of such a course exactly balance."

There seems to be a greater tendency to make the course elective for freshmen in liberal arts colleges than in teachers colleges. Liberal arts colleges are about equally divided as to whether to make the course elective for upperclassmen with a decided tendency in teachers colleges not to make course so elective. In some schools, upperclassmen may receive credit for survey courses by special permission and in other courses limited credit is given. In both types of colleges there is a very decided tendency not to require non-science majors to take additional courses in science. Liberal arts colleges emphatically tend not to count survey courses as a part of the major or minor in science whereas teachers colleges are more evenly divided on the question, with a slight inclination not to do so.

Both schools believe that the same teacher should not teach both the biological science and the physical science. However, the consensus of opinion is emphatically that the same teacher should teach the entire course in each of these divisions rather than bringing in specialists from each of the several divisions of science. At present very few schools are attempting individual laboratory work in survey courses, and the schools that are offering such work are attempting, relatively, very few experiments. The range in credit hours is from three to twelve semester hours with an average of about eight semester hours.

There is a very decided tendency not to use a textbook in the course. Liberal arts colleges prefer to use a syllabus, but the practice in teachers colleges is about evenly divided between those schools using a syllabus and those not using a syllabus. Some excellent syllabi have been developed for survey courses, several of which are not available as yet. Among the meritorious syllabi are those of the University of Chicago, School of Education of New York University, School of Commerce of New York University, the Wharton School of Commerce of the University of Pennsylvania, and Colorado State College of Education.

While the tendency is not to use a specific textbook for the course, the following textbooks, varying somewhat as to relative merit, have appeared in recent years:

TEXTBOOKS FOR SURVEY COURSES

ALLEN, JOHN S. *Survey of Physical Sciences.* Hamilton, New York: Colgate University, 1933. 90 p.

ATWOOD, WILLIAM H., AND HEISS, ELWOOD D. *Educational Biology.* Philadelphia: P. Blakiston's Son and Company. 1933. 475 p. $2.75.

BOSSARD, JAMES H. S. *Man and His World.* New York: Harper and Brothers, 1932. 755 p. $3.50.

BROWNELL, HERBERT. *Physical Science.* New York: McGraw-Hill Book Company, 1931. 313 p. $2.50.

CALDWELL, OTIS W., SKINNER, C. E., and TIETZ, J. W. *Biological Foundations of Education.* Boston: Ginn and Company, 1931. 534 p. $2.72.

EIKENBERRY, W. L., AND WALDRON, R. A. *Educational Biology.* Boston: Ginn and Company. 1930. $2.48.

JEAN, FRANK C., HARRAH, E. CLARENCE, HERMAN, FRED L., AND POWERS, S. RALPH. *Man and the Nature of His Physical Universe.* 524 p. $2.20; *Man and the Nature of His Biological Universe.* 589 p. $2.40, Boston: Ginn and Company, 1934.

JOHNSON, JOHN C. *Educational Biology.* New York: The Macmillan Company, 1930. 360 p. $3.00.

HEIL, L. M. *The Physical World.* Philadelphia, Pa.: P. Blakiston's Son and Company, 1935. 566 p. $2.75.

LEE, RICHARD E. *The Background and Foundations of Science.* Baltimore, Md.: Williams and Wilkins, 1935, 536 p. $4.00.

MCCORKLE, PAUL, AND LEWIS, J. ARTHUR. *College Physical Science.* Phila., Pa.: P. Blakiston's Son and Company, 1934. 327 p. $2.00.

MILLER, CARL W. *An Introduction to Physical Science.* New York: John Wiley and Sons, 1932. 403 p. $3.00.

NEWMAN, H. H., *et. al. The Nature of the World and Man.* Chicago: University of Chicago Press, 1933. 543 p. $1.00.

SYMPOSIUM. *The University Series.* New York: University Society, 1931–1933. 102–156 p. each. $1.25 each.

BAZZONI, CHARLES B. *Energy and Matter.*

BEAN, ROBERT B. *The Races of Man.*

CALKINS, GARY N. *The Smallest Living Things.*

CRAMPTON, HENRY E. *The Coming and Evolution of Life.*

DUNN, L. C. *Heredity and Variation.*

GAGER, C. STUART. *The Plant World.*

LULL, RICHARD S. *Fossils.*

MACCURDY, GEORGE G. *The Coming of Man.*

MENZEL, DONALD H. *Stars and Planets.*

NEEDHAM, JAMES G. *The Animal World.*

REEDS, CHESTER A. *The Earth.*

SHELDON, H. HORTON. *Space, Time and Relativity.*

WENDT, GERALD, AND SMITH, O. F. *Matter and Energy.* Philadelphia, Pa.; P. Blakiston's Son and Company, 1930. 335 p. $1.50.

University of Chicago Series. Chicago, Ill.: University of Chicago Press.

BARTKY, W. *Highlights of Astronomy,* 1935. 280 p. $3.50.

COULTER, M. C. *The Plant Kingdom,* 1935. 270 p. $2.50.

CRONEIS, C., AND KRUMBEIN. *Down to Earth,* 1935. $3.75.

LEMON, H. B. *From Galileo to Cosmic Rays,* 1934. 450 p. $3.75.

LOGSDON, M. I. *The Mathematician Explains,* 1936. 189 p. $2.50.

NEWMAN, H. H. *Evolution, Genetics, and Eugenics,* 1932. 620 p. $3.50.

ROMER, A. S. *Man and the Vertebrates,* 1933. 427 p. $3.00.

STEPHENSON, R. J. *Exploring in Physics,* 1935. 205 p. $1.50.

The few studies that have been reported, and the experience of the writer and others, seem to agree that student opinion is quite favorable to survey courses. In fact the writer has talked with very few students who were not enthusiastic over the course and questionnaire studies in classes have given unanimously favorable returns.

While a majority of all persons to whom the questionnaire was recently sent did not make any comments relative to survey courses, practically all comments made were most favorable and enthusiastic. Many believe that survey courses will prove the salvation of college science courses, the interest kindled in the survey courses leading many students to take additional science courses or to major or minor in science. A few of the unfavorable comments follow:

"No teacher is able to teach both biological and physical sciences."

"Our science departments have never been convinced of the value of such courses."

"Survey courses are superficial in nature, the delight of students who dislike hard work (and these students are in a vast majority in most colleges!), usually taught by persons poorly prepared in science."

"Our experience with this type of course when used as a regular credit course was unfavorable. High school graduates have had too little experience in science to be able to make any growth by taking a survey course as a substitute. Very few teachers can get away with such a course."

"Survey courses are another fad of 'will-o-the-wisp' educators who believe all changes in education mean progress, especially if they can be the one who forwards the 'ism.'"

"Survey courses are the 'pets' of teachers colleges who have always been long on method and short on knowledge of subject-matter."

From this study the following conclusions seem warranted:

Conclusions

1. Survey courses serve as a stimulating preview of a horizontal cross section of all of the sciences. They give the student a panoramic overview of the wonderful universe in which he lives. Survey courses make it possible for the student to correlate and integrate the information from the whole field of science into workable generalizations which will function in his thinking throughout life.
2. There has been a very rapid growth in the last five years in the number of colleges offering science survey courses, and the probability is that the tendency will be accelerated.
3. There is a tendency to make the survey course required, especially for those not majoring in science.

4. Opinion is somewhat divided as to the desirability of permitting upperclassmen to take the course and also as to the amount of credit to be allowed when so taken. Survey courses are now practically confined to the freshman year.
5. Very few schools are offering student laboratory work in survey courses. This may be a fundamental weakness in the present set-up and the writer believes that this phase will and should receive a great deal of attention within the next few years. Demonstrations, including the use of films and slides, seem to be used more extensively than in courses in pure science.
6. Present practices are somewhat evenly divided between those schools using a syllabus and those schools not using a syllabus. The tendency at present is not to use a text-book but to use the wealth of supplementary reading material now available.
7. Experience would seem to indicate that more satisfactory results are obtained when a single instructor has charge of all the work in the given field (*e.g.*, physical science or biological science). The use of different instructors from each of the various departments (specialists in their own field) to give lectures in their respective fields has not worked out well in practice. This, also, seems to be true in regard to the practice of the same instructor teaching both the biological and the physical science phases. It seems to be quite essential that the instructor have good training in each of the sciences within the division in which he is teaching (biological or physical science) and above all that he have enthusiasm for the work based on his beliefs of the essential worthwhileness of the survey course reinforced by thorough preparation in the sciences taught.

There is no doubt that science survey courses have become a permanent and integral part of the science offerings of many liberal arts and teachers colleges. At the pace the list is now being augmented, it will only be a short time until it will be somewhat rare for a college not to include a survey course in its science offerings.

Notwithstanding this present tendency to confine the survey course to the junior college and college level, the writer believes that the survey course may ultimately find its true and rightful place in the secondary school. Instead of the present separate and distinct technical and highly specialized physics and chemistry courses, each struggling to maintain a place in the secondary school, there may emerge a general survey physical science course of one or two years in length, or both. It is the writer's opinion that such a course would serve a more functional purpose, broadened as it would be by offerings from the fields of astronomy, geology, anthropology, physics and chemistry. An analysis of the actual content of these fields affords ample basis for the belief that an integrated course based on content from each of these fields can be formulated. It may well be that the present physics and chemistry courses are on their way out. What will then happen to present junior college science survey courses is problematical. They may continue if essentially modified in their content and emphasis.

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MUSHROOMS: A THIRD-GRADE PROJECT

HELEN LORRAINE HULTZ
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One day while the children were walking along the hillside they had a surprise. Jerry accidentally kicked a soft ball. It didn't bounce, it just broke in two. The children picked up the pieces and examined them. They were soft and white and spongy. Nearby Nancy found an old one. "Look at this," she said, "it won't break." She squeezed it and a puff of purple smoke came out of the hole in the top.

"I know what they are," said Harry. "They are puffballs."

"Nancy has found out why they are called puffballs," said the teacher, "but in olden times they were said to belong to a mischievous gnome of the fields called Puck, and so they were called, 'Puck's balls.' "

The children searched the school lawn and the grassy fields nearby for more puffballs, but while they were hunting they found many mushrooms, too. This started them searching their own lawns, vacant spaces near their homes, and the roadside along their way to school for other mushroom finds.

At first their interest was mainly to find different kinds, but as they began to examine the mushrooms more carefully their hunts took on definite purpose. They started to look for unusual color, for a large or a very tiny mushroom, or one with a different shape. When the children showed the mushrooms they told whether they had found them in the grass, under leaves, on moss, or on trees. They noted that some of the mushrooms had gills and some had pores beneath their caps. They saw that beneath the cap was sometimes a thin veil. They learned, too, that the gills were different colors, sometimes turning dark as the mushroom grew old, sometimes even changing color when touched.

When the children looked carefully they found that often there was a white or colored powder left on the leaves or ground where the mushrooms grew. So they were told to pull off the mushroom caps and lay them down carefully on a piece of paper and cover them. When they looked at the papers at the end of the day they saw the color pattern that the spores made as they dropped out. These spore prints would rub off so when they wanted to make ones they could keep they rubbed their paper first with gum arabic paste.

While making spore prints the children found that some caps would come off the stem very easily. Sometimes they were hard to pull loose, and a few would pull off leaving a hole where the stem had joined the cap. So they looked through a bag of mushrooms to find different ways the gills join the stem. When they finished they had four piles of mushrooms. They labeled them like this:

1. These gills are free from the stem. (Free)
2. These gills are partially joined to the stem. (Adnate)
3. These gills are notched around the stem. (Adnexed)
4. These gills run down the stem and become part of it. (Decurrent)

There were many things the children now wanted to know:

How long can mushrooms live?
Do they grow over night?
How many will grow together?
How often can we find a mushroom crop?
Will other mushrooms grow where we have picked some?

They decided to mark off the mushroom beds on or near the school lawn and watch them. They drove in stakes with orange pennants marked, "Please Do Not Pick the Mushrooms. 3A Is Studying Them." They marked a puffball bed, a cluster of Glistening Coprinus, a bed of Inky Caps, a

group of Shaggy Manes, a patch of Common Meadow mushrooms, and a circle of Boletus. They watched them for several weeks.

Magnifying glasses were very useful for looking at the under surface of the caps, examining cracks or markings in the pileus, or looking at tiny hairs on the stem.

While the children were hunting for mushrooms the following suggestions were put on the blackboard:

1. Watch for a Jack-o-Lantern mushroom. It glows in the dark.
2. Try to find the Inky Coprinus. You can make ink of it. The silver gray color of the cap disappears at touch.
3. Count the rings on a bracket fungus. The rings tell you how old it is.
4. A ring and volva is a sign of a poisonous mushroom.
5. Look for the tiny Marasmius on leaves or twigs.

The children became very anxious to know the names of mushrooms they were finding. A large, colored picture chart of Edible and Poisonous Mushrooms was posted on the bulletin board for them to use. They were also given books with colored plates and pictures to use. Points that would help them identify mushrooms were discussed: the color of the spores; how the gills and stem join; whether the stem has a ring, a volva; where the mushroom was growing; the nature of the spore-bearing surface; the color, and the time of year it was found. After they had found the spore color they were given a preliminary acquaintanceship with an analytical key used in placing a mushroom in its class.

The children kept an exhibit in the hall on which they placed each day's collection. The exhibit changed. One showed a poisonous mushroom, the Destroying Angel (*Amanita phalloides*), with a ring and volva. Another showed it and the Common Meadow Mushroom for which it is often mistaken. A third exhibit showed Shaggy Manes in different stages of growth. Another showed identifying characteristics of mushrooms when cut in two.

The class in charge of the School Museum invited the children to arrange a mushroom exhibit as a special feature. The children thought their exhibit should show:

1. Different Kinds of Mushrooms.
2. A Death Cup and Volva.
3. Spore Prints.
4. Mushroom Ink and the Inky Coprinus.
5. Several Kinds of Mushrooms Cut in Two.
6. Names of the Parts of a Mushroom.
7. Shapes of Mushroom Caps.
8. How Mushrooms Change in Growing—Stages of Growth.
9. A Mushroom Bed Showing Mycelium.
10. How Mushrooms Grow — Manner of Growth.
11. How the Gills Join the Stem.
12. Mushrooms with Gills, Pores, Teeth.
13. Puffballs.
14. Tree Fungi.
15. List of Mushrooms Found.

Groups of children chose the part of the exhibit for which they would be responsible. They went to the woods carrying paper bags to gather mushrooms. They sorted their specimens, arranged them and wrote explanations.

The following suggestions were posted to aid them in further searches:

1. The Tall Lepiota (*Lepiota procera*) grows a foot high. Look for the umbo on its cap.
2. The *Lepiota Morgani* grows in a fairy ring and has green spores. The cap is sometimes 14 inches across.
3. Look for the Masked Tricholoma. It is called blewit, or blue hat, because it looks like a jaunty cocked hat left by an elf hurrying underground.
4. The veil of the Tricholoma leaves a fringe around the cap instead of a ring.
5. Touch and see what happens:
   an *Amanita rubescens.*
   a *Boletinus.*
6. Look for the *Clitocybe* after frosts.
7. Have you found a mushroom with a sticky cap?

Many of the mushrooms which the children had gathered shriveled and dried up. Sometimes they broke easily and crumbled at touch while some of them retained their form and color. This was puzzling. Why

did they dry up? Would they dry up if they didn't pick them; if they left them outdoors? What could they do with their old wrinkled mushrooms? They wondered.

One day they saw this notice:

Put a dried Brick-top in a jar of water and see what happens.
Put an *Amanita muscaria* in water.

The children were delighted when the mushrooms puffed up and looked almost like new. But in a day or two, however, the mushrooms started to mold and had to be thrown out.

The mushrooms would shrink so much in drying and swell so much in water that the children became curious to know how much water they contained. So they weighed out 4 ounces of fresh *Amanita phalloides*. They put them in a paper bag marked with their weight. When they were dry the same mushrooms weighed ½ ounce. They were told that this meant they were 88% water.

The children mounted samples of each of their best dried specimens on pasteboard mounts 8½″ x 10″ and labeled them with their common and scientific names.

They listened to the reading of certain portions of Margaret McKenny's book of MUSHROOMS, especially about the mushroom in folklore, how to identify mushrooms, and descriptions of specimens found.

The children as a group kept a Mushroom Calendar on which different ones entered data about mushroom beds they had found and watched each day to help answer these questions:

How often is there a mushroom crop?
Can we find mushrooms after it snows?
How long does it take a mushroom to grow?
Will mushrooms grow again in the *same* place?
How do mushroom caps change shape in growing?

The children marked off a restricted space in their school garden and dropped mushrooms in it to see if they could start mushroom plants.

Often they would sketch mushroom pictures on the board, on pieces of paper, or paint pictures of some they had found. One of the boys painted an unusually effective one that suggested a poster design. The children used colored chalk on gray bogus paper for making large mushroom posters. Everything in the poster was greatly exaggerated in size, and to keep a proper proportion they worked in a background of grass blades, fallen leaves, part of an old stump, an acorn, a fern leaf, or moss "flowers."

A group of children made a large pictured chart of the gilled mushrooms classified as to spore color. Other groups kept note-books, printed class charts for keeping information about them, or took charge of exhibits.

Some of the questions discussed in class group were:

Where should we look for mushrooms?
What colors are spore prints?
How are the *Amanita phalloides* and the *Agaricus campestris* alike? How different?
What causes the warts on some mushroom caps?
Of what use are the veils?
What things destroy mushrooms?
Which are the most interesting mushrooms?
What things help you recognize different kinds of mushrooms?

A professor of botany who visited the school told the children that they could keep fresh the mushrooms they gathered by putting them in a solution of formalin. They were surprised to know he had kept some 15 years. Would they still make a good spore print? They wanted to know.

The children learned how to dilute the formalin to a 10% solution. They put their mushrooms in but—the mushrooms floated on top. How could they keep them down? They tied stones on, but they were amazed at how big the stones had to be. Sometimes with a heavy enough stone the mushrooms would still float—the string was too long; they had to shorten it. One of the

boys tied a piece of iron pipe. That was much better than stone. They got a long pipe and sawed off small lengths for weights with a hack saw. They weighed their mushrooms and their weights. The boys found they needed three and one-half ounces of stone to hold down a one-ounce mushroom.

They weighed out four ounces of different things, iron, mushroom, and stone, to see the difference in the bulk. Then they filled a glass jar level full of water and dropped in the iron. They measured the water it pushed out. They filled the jar again and pushed the mushroom just under the water surface. They measured the water it pushed out. They did the same with the stone. This gave them an idea of the difference in volume of the substances.

State and government bulletins and reports about the culture and value of mushrooms were studied with the children. They collected such information as follows in regard to the commercial significance.

Mushrooms are very difficult to grow successfully.
Mushrooms for market are grown in modern mushroom houses, cellars, or caves.
Manure is needed from grain fed animals.
Good spawn is important.
Mushrooms need even temperature, between 50 and 60 degrees.
A crop grows from spawn in six or ten weeks.
A mushroom bed in a hot house may bear mushrooms for three or six months or even for a year with proper refrigeration.
Mushrooms, if edible, are good food.
The *Agaricus campestris*, Common Meadow Mushroom, is the common cultivated mushroom in America.

The following experiments were suggested from time to time for the children to do:

1. Find a dead limb on a plum or peach tree with pimply bark. Peel off a bit of the bark where it is broken. Soak the twig in water for a few minutes. Put the twig in a botttle with a little water in the bottom. Watch the little, red, thread-like spore masses that grow.
2. Get a pear leaf with brown spots on it. They are very small spots. Look for the tiny black speck in the center of each spot. Wet the leaf. Watch the fungus threads grow and spread over the leaf.
3. Grow a mold garden on a piece of bread. The mold is a fungus.
4. Make some yeast. Mix flour with it. The fungus makes the mixture rise.
5. Watch the beds of Glistening Coprinus under the apple tree. Water one of the beds each day. How often does it rain? What is the temperature? How often are there mushroom crops? How many mushrooms are there in each bed?

The children made a set of picture mushroom charts with descriptive identifications for the most common mushrooms they found. The descriptions that follow are samples from the charts.

The Shaggy Mane—When it is young the cap is oval shape and fits very close to the stem. As it gets older the cap opens and the edges of it curl up. The gills are first white, then pinkish, and finally black, dripping with a black liquid. The spores are black. The outside of the cap is a dark white and is very scaly. The scales give it a shaggy look which suggested its name. The stem has a soft ring which you can slide up and down. There is a hole in the middle of the stem. There is no death cup. It usually grows to be from two to five inches tall, and about an inch in diameter.

The Fly Amanita—The Fly Amanita is a poisonous mushroom. Long ago people learned it killed flies. That is how it got its name. It has a yellow cap with white scales on the top. The cap is round when it is young. It flattens out, then as it grows older the edges turn up. The spores are white. It has a ring on the stem. It has a cup, or volva, at the bottom of the stem. The danger signals are warts on the top, the volva, and the ring. It is by no means edible. It is a poisonous mushroom. If you ever see one don't eat it.

The Common Meadow Mushroom—This field mushroom has a white cap and pink gills when young and brown when old. The spores are always brownish purple. It grows on lawns and in fields. It has a white circular ring, but no volva. The stem is white, also. It is edible. Sometimes people mistake the Amanita, a very poisonous mushroom, for it. But the Amanita is easy to notice, for it has a white cap, white gills, and white stem. The spores are white. It has both a ring and a death cup. One should never gather the Common Meadow Mushroom to eat until he has learned to tell it from the Amanita.

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THE ORIGIN OF EFFECTIVE LEARNING

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Editor's Note: Following a brief description of a case of conventional school learning in Latin in which the writer, a senior student majoring in science at the School of Education, Syracuse University, deplores the meagerness of activities in the course and the emphasized goal of passing a final regents' examination, he has written his evaluation of a case of real life learning and his impressions of what may be done to make school science work more challenging. Our readers will enjoy and profit by reading that part of his essay, submitted in an Educational Psychology course, which we here reproduce. We are grateful to Dr. G. W. Haupt, of Glassboro, New Jersey, Normal School for recommending the paper to us.

A CASE OF REAL LIFE LEARNING

We have seen in the above illustration the undesirable, unsatisfactory and sometimes even negative results obtained by old-fashioned learning methods. Let us turn our attentions now to a situation where learning is a by-product but not necessarily the goal of an interesting and pleasurable activity. Again, it seems desirable to utilize a personal experience for the sake of illustrating a very important point.

The learning in this case is really the re-

sult of my hobby of collecting insects. In enumerating a few of the things an insect collector and mounter learns of his own volition, and entirely outside of the classroom, the following may be mentioned. I found that a knowledge of the life histories, habitat, and general anatomy of numerous insects was very fascinating as well as practical. A little photography, general chemistry, and even some physics fitted into my avocation. Furthermore, there was always a certain amount of business and social contact with others who were interested in collecting and mounting insects as well as those interested in other hobbies. These are but a few of the things I learned and am constantly learning and utilizing.

Since my early childhood insects and their activities have been of very great interest to me. I often spent hours at a time watching them as they went about their daily tasks of carrying food, eggs, or pollen, fighting their enemies, or preying upon other small creatures. Occasionally, when in a particularly bloodthirsty mood, I fed live ants or flies to some ravenous spider. Honey-bees, traditionally the busybodies of the insect world, were usually my favorite study. Eventually though, I tired of merely watching these tiny creatures and longed to really do something with them. The most beautiful, but not the most easily obtained, were the butterflies and moths; so I decided that they would be the best with which to start a collection. I could catch only a very few by hand or with an old hat, as I did at first. Finally, after experimenting with several different types of insect nets, I perfected a collapsible one that siuted all my purposes. It cost exactly ten cents and about an hour of labor. This, of course, increased my efficiency in collecting both bugs and butterflies and necessitated a more adequate means of preserving them than merely pinning them up here and there.

After talking with a man who had collected butterflies for several years, I learned that empty film packs, for which photographers have no use, make excellent frames for mounting such things. Again, by utilizing a few inexpensive materials, my project advanced by leaps and bounds. My collection began to take on a more professional appearance, and friends and neighbors began to bring me all kinds of odd insects, either for my collection or for identification. As for actual activity in such an undertaking, I have found that one need never worry about being idle. Collecting, of course, involves physical activity. My continual search in new territories for new and different varieties of insects, has kept me out in the open most of the time—hiking, climbing, running and sometimes even swimming. Yet it is not all play. There are times when one has to stand for long hours in the cold waters of some muddy brook or pond, before he can find an evasive cyclops, a back-swimmer, or a whirligig beetle for which he may be searching. There are long, tiresome hikes, discouraging obstacles, and hours of patient study.

Yes, there is actually book-study connected with this hobby, but it is desired rather than dreaded by the learner. There is considerable mental activity involved in the identifying and making the acquaintance of the lives of insects. I once made an illustrated scrapbook of over one-hundred insects, wrote the life histories and collected specimens of each. I have started a small collection of books on insects which I hope to increase greatly and, during the past few years, have used many books from libraries concerning the subject.

Mounting my bugs and butterflies, as well as a few vertebrate forms which I have collected, involves a great deal of activity with the hands. Very frequently during my leisure hours, I may be seen cutting a piece of scrap glass and a piece of cotton to fit into a film pack before mounting a beautiful Luna moth, Tiger swallow-tail, or a collection of weevils. Making my own equipment, such as insect nets, cyanide killing

jars, mountings, and containers for insects, involves considerable manual activity.

The social and cooperative phase of this hobby, although not so evident at a glance, is really one of its most important aspects. I have had many long and interesting chats with people who are interested in insects. Their suggestions and their interest in my work (although I never think of it as "work") have been important incentives, and have inspired me to continue many times when it seemed so much easier to drop it all. As I have said previously, people from all around come bringing me different insects, until now my Mother says, "Everyone in town knows where the 'bughouse' is!" Although my collecting has been done alone for the most part, I have quite frequently gone with groups who either helped me or collected for themselves.

A few of the hobbyists in and about my hometown are planning to organize a "hobby club." My older brother, who is an ardent philatelist outside of his business hours, and I, are both working toward this end. At present we are organizing a group of hobby exhibits for our community fair. This should give us a fairly good index of the interest in such a project and of the number of members we may expect in our club. Such a club would add a great deal to the social value of our various avocations.

Although the primary purpose of most hobbies usually concerns individual activity, many involve social contact, especially where clubs are formed. Nearly every town has its stamp club or its literary club; why not socialize all the hobbies by organizing such a club to which every hobbyist may belong and in which he may take an active part?

You may ask what evidence there is of any real progress in the learning involved in my hobby. The very fact that my collection itself has increased so rapidly and is increasing from week to week, proves that I have made some progress. The fact that I have pored over book after book on entomology, not because I was required to do it, but because I had a real interest in the subject and a desire to acquire the necessary factual information, proves that something really worthwhile has been accomplished. This one outside interest seems to have produced more actual and tangible results than any twenty other interests which were fostered within the schools which I have attended.

Although I have never stopped to analyze the aims of my hobby until now, I believe that they can be briefly summarized as follows in order of their importance to me: (1) Personal satisfaction and recreation during leisure moments; (2) Social activity—organizing a hobby club, associating with scientists and scientific authorities, and making new friends; (3) Personal glorification—who does not take pride in knowing that people "look up" to you as an authority (no matter how poor) on some subject?

I believe I have accomplished each of these aims to some small degree, but I shall never feel that the final goal has been attained and that there is nothing further for which to strive.

MAKING SCHOOL WORK MORE REAL

The title of this section in itself suggests what one should do in order that he might make a school course more like "real life." It says, "Make school work more like the work your students will encounter when they begin to take their places in the world." With this idea in mind, it seems easily possible to make the learning of science in public schools a more interesting, beneficial, and desirable subject for nearly every student. As I have just inferred, my major interest lies in the field of general science. The remainder of this article, therefore, will concern a few general suggestions as to ways in which science subjects might be taught, so that it will be more like the learning which is present in a hobby such as that just described.

First of all the subject must be made interesting. Standardized "interest tests" or

"interest studies" of the pupils will tell fairly accurately where their science interests lie; than a program can be quite easily mapped about these interests. Actual application of the knowledge they acquire within the classroom will motivate them and develop their interests further. This practical application can be made possible by an extensive use of everyday appliances in the laboratory, by field trips, and by visits to industrial plants.

Projects can be worked out where the pupil has an active part in the actual working and applying of the principles of science, and where he will have to cooperate with groups of his classmates. This will bring about both individual and social activity within the classes, and when interest becomes great enough, individual or group contests may be introduced. In addition to the contests, each individual should have a chart, graph, or some other such record, by which he himself may keep a record of his progress in terms of the grades and extra credits which his teacher may give him.

There will always be requests for more material than a teacher can handle in class time alone. When such a situation arises, it is often desirable to suggest, and to guide into existence, a science club. This club should be entirely extra-curricular. It should be organized and carried on entirely by the students themselves with, perhaps, one adult working with them in an advisory position. Advanced interests, problems, or projects, not taken up in class, may be delved into at the science club to their heart's content.

The goal of such a modern method of instruction is multiple, but I think it can best be brought together in the ten following aims. These aims are generally accepted by science teachers today as the most adequate and most complete, but do not think that they are for the teacher alone. With proper guidance they can soon become the ultimate goals of the students as well.

(1) *Utility*—Science should be taught for its usefulness in the lives of those who are learning it, and for its practical value.

(2) *Interpretive Value*—The student should be able to understand and interpret the meaning of natural phenomena occurring about him.

(3) *Scientific Attitude*—Science should create an open-minded curiosity and desire to investigate and weigh all evidence before arriving at any conclusion.

(4) *Scientific Method*—Science should teach one to "think scientifically" on every problem he meets, since this is the most adequate way of thinking.

(5) *Aesthetic Value*—Science should lead to a better appreciation of the beauty in and wonder of nature and natural phenomena.

(6) *Avocational Value*—The cultural and social side of science, if attained, brings about a more worthy use of leisure. ("Hobby science.")

(7) *Ethical Value*—This concerns the bearing of science upon social and moral problems.

(8) *Inculcation of Habits*—The student of science should adopt habits of neatness, accuracy, discrimination between truth and falsity, etc.

(9) *Emotional Standards*—Science should teach one to avoid sudden, unfounded emotions or attitudes of like or dislike of anything novel or strange.

(10) *Vocational Value*—Science should assist in the choice of a vocation and present many fields from which the student may choose.

A SIXTH-GRADE UNIT IN ASTRONOMY

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Origin of the Unit. This astronomy unit was developed with a group of thirty-five sixth-grade children. The fifth-grade teacher had instilled in these children a decided interest in science. They had touched slightly upon the heavenly bodies and were anxious to know more about them. One child had visited the Planetarium at the World's Fair and was eager to tell us what he saw. It seemed timely that our next issue of the *Weekly Reader* should contain an article about the Planetarium at Philadelphia. It was a short step from this point to the question, "Could we make one at school?"

Building the Planetarium. To imagine

something near the ceiling to represent the sky was easy, but to place it there so that the children could work on it was a quite different proposition. At first we thought it impossible, but after much planning we decided to try. We crossed four long pliable boards and fastened them at the center with both screws and heavy twine. The ends we braced with cross bars. With the use of two pulleys and a long strong rope, we raised the framework to the ceiling. Thus we could get it up and out of the way at will. With the framework raised, we spread brown wrapping paper on the floor and painted it for a sky. A deep blue was chosen for the sky, and we obtained it by using plenty of black in the blue mixture.

Each child was eager to paint. There being four long strips of paper, twenty-four children could paint at one time. For this the class was divided into two groups, each painting for ten minutes. In twenty minutes our paper sky was ready. When the paint was dry the paper strips were thumbtacked to the framework. It was remembered that the Planetarium at Philadelphia showed the neighborhood buildings in silhouette fashion at the horizon. We could not be outdone. Ours must have them too. One little girl who was particularly good at sketching trees was chosen to work out this important detail. In sketching and painting the trees and buildings, we left a narrow unpainted margin around them which proved quite effective, as it admitted the light just enough to suggest a faint illumination.

The matter of safety did not occur to us soon enough or we would have fireproofed the paper before painting it, thus avoiding considerable difficulty. As it happened we waited until the planetarium was assembled before spraying it with a fireproof solution, and to our dismay the paper shrank, pulled away at the seams, and in general took on a very much warped appearance. With the use of pins, paper clips and more thumb tacks, we remedied this condition to the best of our ability.

Development of the Unit. Numerous questions arose which were listed on the blackboard. Some of them were:

1. What is the difference between planets and stars?
2. What are constellations?
3. What is a comet?
4. What is a falling star?
5. How do we find out about the stars?

Books in our classroom supplying information of this sort were few in number, and we realized that the Public Library would have to be consulted. Soon we had considerable reference material. Much of this came from the library, but some of it came from the homes of the children. This material was examined and more questions followed, such as:

1. What is the zodiac?
2. What are the signs of the zodiac?
3. How did early people tell time?
4. What are some of the pictures in the sky?
5. What are some of the myths and stories about the stars?
6. Where is the North Star?
7. How do we set our clocks?
8. Why do we have Leap Year?
9. What is the Milky Way?
10. What is a nebula?
11. How far away are some of the stars?
12. How fast does light travel?
13. What causes the seasons?
14. Are other planets inhabited?
15. What are light years?
16. Who invented the telescope?

We divided the questions into two groups. The ones involving the past made one group, and those pertaining to the present made the other.

It was plain that we needed still more books, sky maps and charts, so we wrote letters to various companies for small ten-cent booklets about the stars. We also bought some from the ten-cent stores. A Washington optical company furnished a sky map that could be set for any month of the year. One side of our library was given over to this collection of reference material.

The children were enthusiastic over this new field of study, and began immediately to solve some of its problems. To avoid monotony, various types of lessons were conducted. Sometimes questions would be

asked and answered directly. Sometimes they were assigned for independent research and report. Quite frequently a major problem arose which necessitated the making of an outline to use as a basis for group work. The question, "Why do we have leap year?" brought forth the following sub-topics:

A. Revolution of the earth and moon.

B. The calendar: (1) Julian; (2) Gregorian; (3) Proposed changes in present calendar.

The children were quite surprised to find that it was necessary to skip a leap year every 400 years. One enterprising youngster found out that the year 2300 would be the next leap year to be skipped.

At the beginning we concentrated on the Polar constellations (North Star, Big Dipper, Little Dipper, Cassiopeia and Dragon), first painting them as bright yellow disks on our paper sky, and later trying to find them at night in the real sky. Whenever a child was successful in locating a constellation, he was privileged to write up his observation for our special booklet called the "Astronomical Log." Having successfully located a constellation, a committee was chosen to report to us on the myths and stories that they were able to find. The report took the form of dramatization, and class criticism followed. Many lines were changed from the original rendering, and much of the acting was improved by class suggestion.

We then included other constellations: Orion, Taurus, Auriga and Capella, the dog stars, the Pleiades, and the twins together with the planet Jupiter seen low in the western sky during the winter.

Making Notebooks. Each child developed a notebook for his own use. The children wrote stories of the star myths and drew diagrams of star groups, a comet's path around the sun, the solar system, *etcetera.* Some of these notebooks were exceptional in the material they contained. The children had taken it upon themselves to find out more than was given in the classroom. Each child designed his own cover which in most cases was typically astronomical with comets, stars, telescopes and the like.

Original poems were written for the notebooks. Sometimes these poems expressed deep feeling, and sometimes they took on a humorous strain. Two of our poems are given below.

The Stars

Infinite are the stars
So far, far, far
Where they go nobody seems to know
Celestial and bright
Out in the dark, dark night.

Our Moon

When the moon is shining bright
The stars do twinkle so
But in the morning when the sun does shine
I wonder where they go
And when the moon looks down
She looks like a cradle of gold
So I know the moon is not a cheese
Even though I'm told.

Newspaper Accounts. The children watched eagerly for astronomical news. None proved more interesting than the items about the new telescope. Fortunately for us, the *Weekly Reader* published a lengthy article on the making of the glass for the huge telescope. It also told about the accidental discovery of glass suitable for top-of-the-stove cookery, while experimenting with different formulas for the mechanical eye. One child had these new utensils in his home and was able to show them to the class.

The subject-matter values involved were taken care of rather naturally. Much reading was necessary, and utilized four classes of abilities needed in study done with books. First, the children had to locate their information, which involved skill in the use of the library and general reference books, in using the index and the table of contents, and in skimming to locate certain information. Second, they had to comprehend accurately what they read, select items for their purpose, and appraise the value of these items. Third, they had to organize

their data to fit the purpose for which they were reading. Fourth, they had to remember what they read. Then, too, the myths about the stars provided excellent reading of the literary type.

Arithmetic. The children made up problems using as a basis the distance from the earth of certain planets and stars. The distances of stars we sometimes computed in light years. The tremendous size of the numbers challenged the youngsters to work out a competitive game. Numbers representing these huge distances were written on the blackboard, then the class was divided into groups forming number teams, and lined up the same as in a spelling match. Whenever a number was read incorrectly, the child reading it sat down. At the end of ten minutes the children were counted, and the team having the greatest number standing was the winner. We also worked out problems involving difference in time.

Art Work. The pictures in the sky were painted on large pieces of poster paper. At first the children were at a loss to know what colors to use, but after realizing that the sky pictures were purely imaginary anyway, the problem resolved itself into blending and harmonizing with other things in the room.

Culmination of the Unit. We invited parents and other grades to visit our Planetarium. Chairs were placed in a circle beneath the dome-like paper construction, and the whole contraption lowered so that the sky line was about on a level with the eyes of the audience when seated. A globe was tilted so that its axis pointed to the North star. One child was chosen to give the lecture, which was something as follows:

We have been studying a little about astronomy. We have heard of different planetariums, so we decided to make one. Our Planetarium represents the sky on any clear night during January, February or March about eight o'clock. The chalky line that runs across it represents the Milky Way. The constellations are (as he points to them) Ursa Major, Ursa Minor, Cassiopeia, Auriga, Orion, Taurus, The Pleiades, Gemini, Canis Major, Canis Minor, and the planet Jupiter. There are some constellations that never go beyond the horizon. Among these are Ursa Major, Ursa Minor and Cassiopeia. The constellation Ursa Major is especially known for the small star Alcor. It is often called the test star because only people with good eyes can see it.

Of all the constellations there is no doubt but what Orion is the greatest. It is found so easily by the three stars which mark his belt. These have been known and famed down through the ages and have been called different things by different people. The Africans knew them as the three pigs. The Eskimoes knew them as footsteps in the snow banks. The Persians knew them as the string of pearls, and last of all the Greeks knew them as Orion's belt.

Betelguese marks Orion's right armpit. It is 160 light years away. It is a giant red star, is one of the youngest stars, and is traveling away from the earth at the rate of 10½ miles per second. Rigel marks Orion's left foot. It is a white star, the brightest in Orion, and is traveling away from the earth at the rate of 15 miles per second. Sirius, found by continuing eastward the line made by the belt, is the brightest star in the winter sky. It was known as the dog star by the Egyptians because it rose with the river Nile and warned them of the flood that was in the near future. It is eight light years away. The Pleiades is very interesting. To the naked eye six or seven dim stars can be seen, but through the larger telescopes more than three thousand can be found in this nebula.

The earth's axis is always tilted 23½ degrees from the perpendicular, and is pointing to the North Star. This is a factor in making the seasons. If the earth's axis were pointing to the zenith we would have one season all of the time. (At this point he demonstrated by carrying the globe around an imaginary sun).

The skyline represents the horizon. These are the different scenes around Washington. (Pointing) Bancroft School, The Capitol, The Washington Monument, and other important places.

The remainder of the program consisted of: (a) dramatization of sky myths; (b) singing of star songs; (c) reading of original poems; (d) showing the notebooks; and (e) giving an account of the telescope, making clear that if it had not been for this valuable instrument we still would be making up stories to explain the stars.

Evidences of a sustained interest in this field have manifested themselves in continued trips to visit a planetarium, recreational reading about the stars, and in the organization of a science club at our school.

FACT VERSUS THEORY

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The method that the scientist uses in solving problems in his own particular field is one that has undoubtedly borne fruit. The scientist, in considering his problems, can hardly be expected to advance very far towards their solutions, unless, in relation to his science thinking at least, he has the habit of mind called the scientific attitude.

The scientific attitude might be described as a habit of mind which recognizes the likelihood of reaching invalid conclusions unless certain precautions are taken. Making up this scientific attitude, this habit of thinking, are three elements: first, a recognition of man's likelihood of arriving at invalid conclusions (invalid, that is, in view of the facts); second, an awareness of the causes, usually emotional, that operate to warp our judgments; third, the intellectual integrity or will power actually to counteract or eliminate the effect on our thinking of these deleterious causes.

Among the mental habits known to be inconsistent with the scientific attitude and, therefore, leading to erroneous conclusions, are: (1) inability to distinguish between fact and theory; (2) unwillingness to hold suspended judgments until all the facts are at hand; (3) unwillingness to change opinion on the basis of evidence, the closed mind; (4) personal, religious and social prejudice; (5) superstitious beliefs; (6) no felt need for cause and effect relationships; (7) unwarranted desire to argue for argument's sake, primarily to advance the ego.

Of these I have elected to discuss the frequently overlooked or disregarded distinction between fact and theory. A fact (in science) is a very carefully made observation, many times repeated and checked by several skilled observers (scientists). [The word "checked" has been used advisedly in preference to the word "verified," to avoid controversy regarding man's ability ever to know truth.] Briefly, the facts are the data the scientist records. Theories, of course, are merely assumptions which offer us more or less satisfactory explanations of observed phenomena.

Before one has given much thought to this matter, he is apt to regard it not, in itself, as unimportant but rather as not really worthy of much consideration because of the supposedly comparative ease with which one can recognize a fact or a theory as such. However, preliminary tests given at the Abraham Lincoln High School lead to the same tentative conclusions as those drawn by Davis in his paper[1] previously referred to. He states, "Many of the theories in science are being taught as facts by many of our best teachers. Teachers as well as pupils fail to distinguish clearly facts from theories." The far-reaching importance and significance of this one point from the standpoint of science teaching and hence, as it affects all society, are ably presented in an article by Gruenberg.[2]

Having been made aware of the ease with which we accept and offer hypotheses as facts, I examined, for the first time critically, a typical, good textbook widely used in teaching elementary high-school physics. My object was, of course, to determine to what extent fact and theory were confused; that is, to what extent hypotheses were offered as facts. I made two rather interesting discoveries, the first being the remarkable frequency with which this book presented an assumption as a fact, and the second, the ease with which I, time and again, accepted these hypotheses as facts, even at the very time I was hunting specifically for

[1] Davis, Ira C. "The Measurement of Scientific Attitudes." *Science Education* 19: 117–122; October, 1935.

[2] Gruenberg, B. C. "Hypothesis and Doctrine in Science Teaching." *School and Society* 37: 601; May 13, 1933.

this type of error. Parenthetically, it is well to note that other science textbooks, including those in use at colleges as well as in high schools, fall into the same pitfall with more or less the same frequency.

As intimated above, my method of procedure consisted in searching through the text, critically examining the hypotheses and explanations, and noting where theories and asumptions were either stated as facts or presented so as to imply that they were facts.

Not one of the quoted statements listed below is a statement of fact; each is an assumption or is based on some accepted working hypothesis. (Where the same statement appears several times in the book I have not repeated it.)

> "In reality, no kind of matter can be subdivided beyond a certain point without losing its identity."
>
> "No one has ever seen a molecule; these particles are so small that the best microscope fails to reveal them."
>
> "By indirect methods it has been learned that one liter of air contains 27×10^{21} molecules."
>
> "The molecule is made up of atoms."
>
> "We have learned that all matter is composed of very small particles called molecules, which are in constant motion. As the velocity of the molecules of a body increases, its temperature rises."

In discussing the behavior of a gas as it is cooled below 0° C., the following statement is made:

> "It continues to contract, losing $\frac{1}{273}$ of its volume for every degree that it is cooled below zero."
>
> "When it dissolves in the water, a part of its molecules dissociate into ions. Each hydrogen ion (H^+) carries a positive charge of electricity and the sulfate ion ($SO_4^=$) is negatively charged."
>
> "If we hold a negatively charged rod near the knob of an electroscope, the electrons are repelled and stream away from the knob to the leaves."
>
> "The electrons streaming along a conductor form an electric curent."
>
> "The strength of the induced E.M.F. depends upon the number of lines cut per second. Experiment shows that 100,000,000 lines of force must be cut per second to produce an induced E.M.F. of one volt."
>
> "The atoms of radium and other radioactive elements are exploding or disintegrating."
>
> "In the laboratory the chemist builds up new molecules from atoms or rearranges the atoms in the molecule. By means of the X-ray, scientists have studied the arrangement of the atoms in certain molecules. (See Fig. 2)."

Figure 2 shows alternate black and white spheres connected by lines and arranged to form a cube. The drawing is labeled,

> "Structure of the molecule of common table salt."
>
> "The atom has a nucleus made up of positively charged particles called protons. Some negatively charged particles are also present in the nucleus but there is always an excess of protons. Surrounding the nucleus and probably revolving around it in a manner similar to the revolution of the planets around the sun, there are extremely small particles, each carrying a charge of negative electricity. These particles are called electrons. The hydrogen atom is the lightest atom known, but the electron is only about 1/1840 as heavy as the hydrogen atom."

Even so eminent a writer as James Kendall, in his 1926 revised and rewritten edition of *Smith's Inorganic Chemistry,* while stressing the status of a hypothesis as an assumed state of affairs, nevertheless states that the accumulated evidence has verified the kinetic-molecular hypothesis beyond all possibility of doubt. This would mean that we know that all matter is composed of exceedingly minute discrete particles or molecules.

Eldridge, in *The Physical Basis of Things,* concludes that the reality of molecules has been demonstrated by experiments that are interpreted as actually measuring the sizes of molecules. Yet, he later in the same volume quotes the Davisson-Germer experiment as demonstrating the wave nature of the molecule (and of the electron).

During the fall term 1933–1934, at the request of the Chemistry Teachers' Club of New York City, Professor J. A. Babor of the College of the City of New York gave a brief survey chemistry course to a group of interested high-school teachers.

My lecture notes include his statement that it is possible to make up so dilute a solution of a dye that even though the color can still be seen, calculations show the presence of only a fraction of a molecule.

Science advances through its theories,—but once a postulate is confused with a fact, it is my feeling that the result is analogous to a paralysis of the thinking process. The confusion automatically shuts off the searching for a more satisfactory theory—one that may be nearer the truth and may therefore hasten the progress of science.

The following quotations are obviously incompatible with the widely accepted theory of relativity. Certainly, they should not be offered as facts.

"Matter is indestructible."

"Hence the total quantity of matter in the universe is the same today as yesterday. The fact that matter cannot be created or destroyed is usually called the law of the conservation of matter."

"An iron rod contains the same quantity of matter anywhere on the earth or 1000 miles above the earth; its mass is constant."

"Like matter itself, energy can neither be created nor destroyed. There is the same amount of energy in the universe today that there was yesterday and the amount will be unchanged tomorrow. These facts show why the output of a machine can never exceed the input. A perpetual motion machine is utterly impossible."

"The fact that energy may be transformed or transferred but cannot be destroyed, is known as the law of conservation of energy."

"Everyone knows that the earth exerts an attractive force that tends to pull all objects toward it."

"Sir Isaac Newton called attention to the facts that gravitation is universal and that bodies have a mutual attraction."

"This force of mutual attraction depends upon two things: ——."

"The weight of a body is really a measure of the earth's attraction for that body."

(For an excellent review of the various theories of gravitation from Aristotle to Einstein, see P. R. Heyl's article.[3])

[3] Paul R. Heyl. "Old and New Ideas Regarding Gravitation." *Jour. Chem. Ed.*, Nov. 1932, Vol. IX, No. 11, Pg. 1897.

After reading the preceding quotations the reader, though perhaps agreeing with me in theory, may still object in practice on the grounds of time and space limitation. To avoid such statements, he may say, it would be necessary for teachers and for textbook writers to devote an unwarranted amount of time and of space in explaining and qualifying each such statement. The flow of thought would be unduly interrupted. The pupils would have practically nothing definite to cling to. If we were to stop to point out clearly each time we were using assumptions and not facts, the teacher may finally urge, we would never put across our subject matter.

I agree that by offering such concise statements as I have quoted, rather than qualified statements, it is easier to teach the topics in the syllabus. It is also easier for the pupils to follow such explanations and learn them, and much more satisfying to our pupils to accept such explanations as the truth rather than as tentative working hypotheses. Nevertheless, if the teachers, the textbook writers and the pupils take that less arduous path, the teachers are not imparting the scientific attitude and the pupils are most likely not acquiring it.

We teach pupils physics or chemistry, if we agree with the writers of the N. Y. State Syllabi in these subjects, in order to attain certain objectives. Chief among these should be "habits useful in life, and not habits limited to application in further study of a particular science."

"Most important of all, the pupil should be started along the road to a scientific habit of mind, with fearless inspection of data and conclusions, and with the development of intellectual honesty and love of truth that will carry over into his future judgments in all subjects of life."

Are we starting our pupils along this desirable path while in our very science teaching we continue to indoctrinate?

ELEMENTARY SCHOOL SCIENCE REFERENCES AND INSTRUCTIONAL MATERIALS*

G. V. BRUCE

New Jersey State Teachers College, Newark, New Jersey

BIBLIOGRAPHY NO. I. SCIENCE REFERENCE MATERIALS FOR CHILDREN**

7. ASTRONOMY

BARRITT, LEON. *Atlas of Astronomical Photographs.* Celestial Map Publishing Co., 244 Adams St., Brooklyn, N. Y. 1935.

This is a group of more than a hundred superior photographs of significant features of the heavens that have been taken by the great observatories. They would be excellent for opaque projection. Grades 6–up. $2.50.

BARRITT, LEON, (Editor). *The Monthly Evening Sky Map.* The Celestial Map Publishing Co., 244 Adams St., Brooklyn, N. Y.

This is a journal for the amateur which contains the sky maps, mercator projection and all the news of the changing drama of the stars, constellations, planets and meteors. It gives the news of the Amateur Astronomers' Association and announces coming radio talks and activities in general. Yearly subscription, $1.50.

CHANT, C. A. *Our Wonderful Universe.* World Book Co., Park Hill, Yonkers-on-Hudson, N. Y. 1929.

A small book which is an excellent piece of teaching in elementary astronomy. The illustrations and other graphical devices are exceptionally clear. $1.52.

COLLINS, A. F. *The Book of Stars.* D. Appleton and Co., 35 West 32nd St., New York.

This furnishes practical and simple directions for identifying the stars and constellations, for telling time by sun or moon and for finding the way by the stars. It is illustrated with helpful diagrams. Grades 7–9. $1.50.

COLLINS, A. FREDERICK. *The Boy Astronomer.* Lothrop, Lee and Shepard Co., 275 Congress St., Boston, Mass. 1928.

This begins with an historical sketch of astronomy and then the author explains how to make and use star finders, the construction and working of telescopes, and how to know the different heavenly bodies. It is illustrated with 175 diagrams. Grades 5–9. $2.00.

* Continued from April, 1936, issue.

** For further useful materials in astronomy, geology and weather for children, refer to Bibliographies No. I—1 General Science Series and Readers, and No. I—2 General Nature Series and Readers, in past issues of SCIENCE EDUCATION.

FROST, EDWIN BRANT. *Let's Look at the Stars.* Houghton Mifflin Company, 2 Park St., Boston, Mass. 1935.

A comprehensive flight of the mind through the heavens by the director Emeritus of the Yerkes Observatory. It presents all the phenomena of the solar system, our stellar galaxy and the island universes in a way to challenge children and to interest adults. Grades 6–up. $1.00.

HAYDEN PLANETARIUM. Published by the American Museum of Natural History, 77th Street and Central Park West, New York City.

This is a monthly bulletin which presents "The Drama of the Skies" for the amateur. It carries interesting illustrations and all the current news of the astronomical world the layman would want to know. Per copy, $0.10. Yearly subscription, $1.00.

JOHNSON, GAYLORD. *Star People.* The Macmillan Co., 60 Fifth Ave., New York. 1921.

This book is devoted to the stars and constellations. Twin brothers, Peter and Paul, learn the mysteries of the heavens in conversational way from their Uncle who uses all kinds of graphical methods to make it clear. Grades 4–6. $1.50.

JOHNSON, GAYLORD. *The Sky Movies.* The Macmillan Co., 60 Fifth Ave., New York. 1928.

This is a companion book of the STAR PEOPLE. It utilizes the same clever devices for making the location, and movements of the planets and moon clear and interesting to children. Grades 4–6. $1.50.

KINNEY, MURIEL. *Stars and Their Stories.* D. Appleton and Co., 35 West 32nd St., New York.

This teaches young people to recognize the more important constellations by means of simple star charts for every month. It tells briefly in simple and colorful language the myths that lie back of the naming of the constellations, such as Orion, the Great and Little Bear, the Taurus, Capella, Pegasus and the rest. Grades 4–5. $1.25.

LEWIS, ISABEL. *Astronomy for Young Folks.* Duffield and Green, Inc., 200 Madison Ave., New York. 1932.

This is one of the most readable books in astronomy. It presents the constellations month by month, discusses the planets, the sun, moon, comets, meteors and some of the stars. Grades 6–9. $2.00.

Lockwood, Marian, and Draper, Arthur L. *The Earth Among the Stars.* Basic Books, 1182 Broadway, New York. 1935.

This little book is a broad account of the astronomical universe for children. It is dramatic but scientifically authentic. Grades 4–6. $0.35.

Marmer, H. A. *The Tide.* D. Appleton and Co., 35 West 32nd St., New York.

This is an accurate and non-technical account of the sometimes mystifying phenomena of the tides. It includes the history of the development of tidal knowledge from ancient times. Grades 6–up. $2.50.

Mitton, G. W. *The Book of Stars for Young People.* The Macmillan Co., 60 Fifth Ave., New York. 1925.

This presents the principal astronomical facts in a clear and interesting way. There are many unusual illustrations in color besides diagrams and photographs. Grades 6–9. $2.50.

Olcott, Wm. T. *Book of the Stars for Young People.* G. P. Putnam's Sons, 2 West 45th St., New York. 1923.

Mr. Olcott shows how you can find pictures in the skies, how you can learn the names of the stars. This book contains a delightful amount of star lore. Copiously illustrated. Grades 5–8. $3.00.

Olcott, William T. *Sun Lore of All Ages.* G. P. Putnam's Sons, 2 W. 45th St., New York. 1930.

The same as with Star Lore of All Ages, the author has collected the myths, legends and superstitions of many peoples concerning the sun. It is probably the most comprehensive and authentic work on the subject. Grades 6–up. $5.00.

Olcott, William T., and Putnam, Edmund M. *Field Book of the Skies.* G. P. Putnam's Sons, 2 W. 45th St., New York. 1929.

This book aims to give a comprehensive body of useful knowledge of astronomy, a brief outline of the mythology of the heavens and to teach the beginner how to identify the constellations. Grades 6–up. $5.00.

Phillips, T. E. R., and Steavenson, W. H. *Splendours of the Heavens.* Robert M. McBride and Co., 4 West 16th St., New York. 1932.

This is a most remarkable book in astronomy for the elementary student and the adult. It contains hundreds of unusual illustrations that make the whole story of the heavens simple and visual. Grades—all levels. $7.00.

Popular Science Monthly Editorial Staff. *Astronomy For Amateurs.* Grosset and Dunlap, New York. 1934.

This is an activity book in astronomy for elementary students. It contains numerous simple experiments and construction activities, such as: setting your watch by a star, determining latitude and longitude of the school, measuring the moon's diameter, photographing the moon, constructing and using a sun dial, and so forth. The directions and diagrams are simple enough that elementary children may become interested in carrying them out. At the same time they are challenging enough to command the interest of the adult. Grades 6 up. $1.00.

Proctor, Mary. *Legends of the Stars.* George G. Harrap and Co., London. 1922.

To those children who have learned some of the constellations it may prove an added interest to associate some of the legends with them. This book has adapted the legends specifically to this purpose. Grades 4–9. $1.50.

Proctor, Mary. *The Young Folk Book of the Heavens.* Little, Brown and Co., 34 Beacon St., Boston, Mass. 1925.

This book is designed by the author for the purpose of interesting boys and girls. The author had in mind those who may have more than a casual interest and has tried to bring in the spirit of astronomy and let them see it at work in the present day. Grades 4–9. $2.00.

Reed, W. Maxwell. *The Stars For Sam.* Harcourt, Brace and Company, 383 Madison Ave., New York. 1930.

Both young and old will find this book interesting. They will enjoy the chapters on the sun, on the planets, on meteors and comets, Einstein, space and time, and other topics. Grades 6–up. $3.00.

Reh, Frank. *Astronomy For the Layman.* D. Appleton-Century Company, 35 West 32nd St., New York. 1936.

This book covers practically every phase of astronomy. It is written in a popular style that will appeal to the amateur and layman. It is copiously illustrated. It bears a foreword by Clyde Fisher. Grades 6–up. $3.00.

Renwick, Dorothy. *Star Myths From Many Lands.* Charles Scribner's Sons, 597 Fifth Ave., New York. 1931.

Boys and girls who have wondered about the stars and their stories will find retold in this book the interesting myths which have grown up from earliest times. Though primarily a story book, *Star Myths from Many Lands* may help to promote interest in elementary astronomy. Grades 4–6. $0.88.

SCHWARTZ, A. *Little Star Gazers.* F. A. Stokes Co., 443 Fourth Ave., New York. 1934.
Stories of how children in other ages have looked up in wonder at the same stars—the boy of ancient Egypt who told the time by them; the Greek child who saw in them gods and monsters—and so on, through the centuries. Illustrations in color. $1.50.

SERVISS, G. P. *The Story of the Moon.* D. Appleton and Co., 35 West 32nd St., New York. 1928.
This is in the form of a conversation between an astronomer and an inquirer. It covers such aspects as mountains, valleys, craters, light effects and discusses a hypothetical trip to the moon. It contains photographic illustrations. $3.00.

STEVENS, BERTHA. *Children and Universe.* The John Day Co., 386 Fourth Ave., New York. 1931.
The author uses this book to put into the hands of teachers and parents the means of impressing the child with the oneness, order and beauty of the cosmos. It contains 48 full page excellent illustrations. $3.75.

SWEZEY, DELOSE G., and GABLE, J. HARRIS. *Boys Book of Astronomy.* E. P. Dutton and Co., 286 Fourth Ave., New York. 1929.
This is in the nature of an astronomy text for young people. It is a complete story of the astronomical world, and well organized and adequately illustrated and contains challenging devices for active study. Grades 4–9. $2.00.

TRAFTON, GILBERT H. *The Sky Book.* The Slingerland-Comstock Co., Ithaca, N. Y. 1925.
This is a very complete guide for sky study. It has excellent plates of the circumpolar, winter, spring, summer and autumn constellations. By a system of guide lines it carries one from constellation to constellation entirely around the sky. It has quantities of well-organized information on the heavenly bodies and also a section on "How to Know Clouds." Grades 6–up. $0.75.

WHITE, W. B. *Seeing Stars.* D. C. Heath and Co., 1815 Prairie Ave., Chicago, Ill. 1935.
This little booklet contains a comprehensive story of the heavens, fully illustrated. It is one of the clearest guides to the study of the sky. The guide and story for each constellation is accompanied by a list of objects for observation with the unaided eye, the field glass and a small telescope. It contains also valuable information about the solar system. Grades 1–4 and older. $0.10.

WILLIAMSON, JULIA, and REINDEL, EDNA M. *Stars Through Magic Casements.* D. Appleton and Company, 35 West 32nd St., New York. 1930.
A collection of stories about stars told in a fascinating way for the entertainment of boys and girls. The stories are short and the style is conversational. Grades 6–9. $1.00.

8. GEOLOGY

COOPER, F. T. *Little Gold Nugget.* F. A. Stokes Co., 443 Fourth Ave., New York.
A little girl is allowed to explore the family chest of jewelry and old coins. She becomes acquainted with a lively and enterprising gold-piece who tells her his whole story from the gold mine to the mint and afterward, with many adventures by the way. Illustrated. Grades 3–5. $1.00.

ELIOT, E. C. *The Little Black Coal.* F. A. Stokes Co., 443 Fourth Ave., New York.
Geology for little children, told through the autobiography of a little coal in the nursery scuttle. The author succeeds in giving a vivid picture of the prehistoric forest in which the coal was a cone on a prehistoric tree, and carries her story on through every stage of the coal's life in a simple, always interesting style. Illustrated. Grades 3–5. $1.00.

ENGLISH, GEORGE L. *Getting Acquainted With the Minerals.* Mineralogical Publishing Co., 50 Brighton St., Rochester, N. Y. 1935.
This is an easily understood treatment of minerals—their history and characteristics and identification. It contains 258 clear illustrations, many of them in the natural colors. The book would be extremely valuable to the amateur. Grades 6–up. $2.00.

FENTON, CARROLL LANE. *Along the Hill.* Reynal and Hitchcock, 386 Fourth Ave., New York. 1936.
This is a little book giving the story of earth history in a way that can be understood by small children. It is well illustrated in simple black and white sketches. Grades 1–3. $0.50.

HARDY, MARY. *Nature's Wonder Lore.* Rand McNally and Co., 111 Eighth Ave., New York.
This presents the most elementary phases of geology in the form of a series of imaginative stories planned to appeal to the child. It is illustrated with drawings and thirty out-of-door photographs. Grades 4–6. $0.68.

HAWKSWORTH, H. *The Adventures of a Grain of Dust.* Charles Scribner's Sons, 597 Fifth Ave., New York. 1922.
Tells how nature makes from the stones of the field the soil that gives us bread, and how by ingenious methods she fertilizes it and makes it ready for the plow. Grades 6–8. $1.20.

HAWKSWORTH, H. *The Strange Adventures of a Pebble.* Charles Scribner's Sons, 597 Fifth Ave., New York. 1921.
The physical story of the earth, with unusual illustrations and graphic descriptions in conversational form. Grades 6–8. $1.20.

KUMMER, FREDERIC ARNOLD. *The Earth's Story.* George H. Doran Co., 38 West 32nd St., New York. 1922–1925.

These three books attempt the prodigious task of presenting the whole fabric of present knowledge that has been painfully gathered during many centuries so that children will comprehend and enjoy it. It is done in a graphic and colorful way but the essential truths are maintained. Grades 6–9. Each $1.00.

Volume I, *The First Days of Man.*
Volume II, *The First Days of Knowledge.*
Volume III, *The First Days of History.*

KNIGHT, CHARLES R. *Before the Dawn of History.* McGraw-Hill Book Co., 330 W. 42nd Street, New York. 1935.

This is a remarkable book both for its content and its physical features. It contains a full series of large sepia illustrations depicting the flora and fauna of the various geological periods with appropriate descriptive material accompanying each. Grades 4–9. $4.00.

MIX, I. J. *Mighty Animals.* American Book Co., 88 Lexington Ave., New York.

Scientific information about the gigantic animals and reptiles that lived on the earth before man appeared—the dinosaur, the megatherium, the mastodon, and others. Grades 5–8. $0.52.

REED, W. MAXWELL. *The Earth for Sam.* Harcourt, Brace and Co., 383 Madison Ave., New York.

An interestingly written and exceptionally well-illustrated story of the earth from the beginnings of life to the dawn of history. Mr. Reed writes a straightforward story which like all good children's books can be read with pleasure by adults. Grades 6–up. $3.50.

SEERS, WADDINGHAM A. *The Earth and Its Life.* World Book Co., Yonkers-on-Hudson, N. Y. 1923.

This book contains a clear account of the origin of our planet in the light of modern science. It recounts the story of evolution and relates man's struggle against the animal world and his final triumph. Interesting to older people as well as children. Grades 6–up. $1.20.

SPENCER, L. J. *The World of Minerals.* Frederick A. Stokes Co., 443 Fourth Ave., New York. 1934.

This is an invaluable aid to the amateur for the identification of rocks and minerals. It contains hundreds of illustrations in color that are so clear and realistic as to make identification quite obvious. Grades 6–up. $2.00.

WASHBURN, C. H., and REED, F. *The Story of Earth and Sky.* The Century Company, 353 Fourth Ave., New York. 1933.

This is an interestingly gotten up book which combines the geological story of the earth and its astronomical setting in the rest of the universe. It is well illustrated and designed to interest young children. Grades 4–9. $3.30.

9. WEATHER

BARNEY, MAGINEL WRIGHT. *Weather Signs and Rhymes.* Alfred A. Knopf, 730 Fifth Ave., New York. 1931.

The interest of small children may be directed to a weather consciousness by this remarkable little book. It is filled with weather lore and intriguing illustrations. The game is to watch the weather through the seasons to see how many of them come true. Grades 1–4. $1.00.

CAVE, C. J. P. *Clouds and Weather Phenomena.* The Macmillan Company, 60 Fifth Ave., New York. 1930.

This book explains the colors of the sunrise and sunset, the rainbow, the twilight and other color phenomena of the sky. It contains forty-seven excellent photographs of clouds and helps to identify them by name. Grades 6–9. $1.75.

RIDGLEY, DOUGLAS C. *General Circulation of the Atmosphere.* McKnight and McKnight Company, Bloomington, Ill. 1933.

This is a concise treatment of the wind belts of the earth. It presents the facts of air movements that are essential to understanding the distribution of rainfall. Grades 6–9. $0.15.

WILLIAMS, A. F. *Everyone's Book of the Weather.* The Macmillan Co., 60 Fifth Ave., New York. 1923.

This book presents the general facts of meteorology in a popular form and shows how observers equipped with simple instruments can find pleasure and profit in the study of weather conditions. Grades 6–9. $1.00.

Classroom Notes

Vibrating air columns—simple demonstrations.—The experiments with simple apparatus described here are easily adaptable to the capacities of science-study groups of almost any age. They serve to enrich class discussion of sound phenomena and they may be used effectively as classroom student-demonstrations. These materials have been employed at various times in organizing sound lectures before school assemblies.

Success with the experiments depends upon a properly constructed air-blower devised by the writer many years ago (Figure 1). It was made from a Bunsen burner

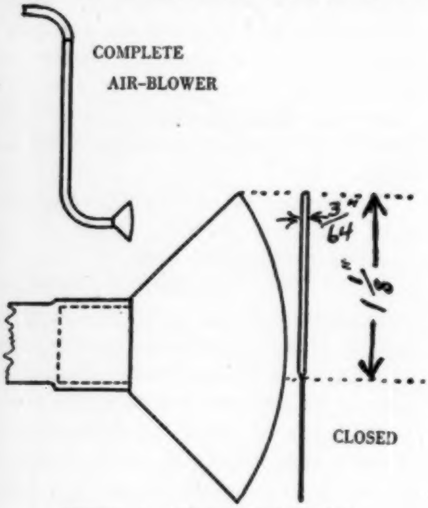


FIGURE 1.—Blower and Outlet

wingtop, a piece of large-bore rubber tubing (not less than ¼ in. inside diameter and about 20 in. long) and a glass L-tube of the same bore for a mouth-piece. The bore of the tube should be ample to provide adequate air flow and velocity at the outlet.

* Part of a demonstration-lecture before the School Assembly of the Eleanor Van Gelder School of Edgewater, N. J.

Certain details are indicated in the accompanying sketch.

The outlet opening of the wingtop was compressed to 3/64 in. width by means of pliers with a 3/64 in. strip of metal sheet set in the opening to serve as a form. For economy of air flow the length of the opening was reduced to about 1⅛ in. by pinching part of the wingtop opening completely shut as shown in the sketch. To provide for the best streamline jet of air the outer edges of the wingtop lips were slightly beveled. The flattened part of the wingtop leading to the outlet had a slight taper and the lips were filed to equal length.

This air-blower may be used to produce musical tones from many types and sizes of bottles, tubes, etc., extending over the entire range of audition. A tone from the small opening in the end of a cabinet key was used to produce a barely audible squeak illustrating the upper auditory limit, while the lower limit was obtained from a 5-gallon distilled-water bottle. With the bottle half full of water the vibrations from the enclosed air were distinguishable as a very low tone. Then by removing some water the oscillations were made inaudible as a tone but slightly perceptible as a flutter.

In using the blower to produce a tone from an ordinary wide-mouth bottle or jar the edge of the blower is held part way over the mouth of the vessel with the air-jet directed at the opposite edge. To find the proper angle and the best air pressure requires a little experimental technique. Lung power may be conserved by tooting the apparatus till the correct position and pressure are obtained. As in the case of organ pipes, the air column of a tube of small diameter tends to break into the overtones as the air pressure is increased.

Bottles, flasks, jugs and tubes of glass and other materials may be employed for demonstrating whistles, organ-pipes, the flute, the bugle, the trombone and other horn instruments as well as the resonance effects in the human voice. With a little practice an ordinary florence flask may be induced to emit two tones simultaneously: the low-pitched tone of the entire air volume and the high-pitched tone of the neck of the flask vibrating as tube opens at both ends.

A musical scale of eight notes was obtained from eight small olive bottles of approximately 6½ in. depth, 1⅜ in. mouth diameter, and 1½ in. inside diameter. These bottles were filled with the required amounts of water to represent the octave C-512 to C-1024. The proper lengths of air-columns for these notes were located by resonance with tuning-forks for the diatonic scale. File marks were then cut on the bottles to show the correct water-level. These water-marks may be obtained also with sufficient accuracy from the corresponding piano tones by ear. Paraffin may be used instead of water for permanent settings. It may be observed experimentally that the pitch of the tone obtained from a bottle or a tube varies considerably with the area of the mouth-opening. For example, the pitch drops perceptibly if the mouth of the bottle is partly covered with a piece of cardboard. With a little practice the olive-bottle tones may be used to play a simple melody.

The overtones of the harmonic series as exemplified in the bugle, the trombone and other horn instruments were obtained with the air-blower by using a glass tube of 25 centimeters in length; 15 millimeters in inside diameter and 2 millimeters in thickness of wall. The ends were carefully ground flat and square on a revolving stone with inside and outside edges slightly beveled. By holding the blower in proper position against the end of the tube and tooting it four or more overtones of the open tube were obtained in addition to the fundamental. For the higher overtones it was necessary to move the mouth of the blower closer to the edge and to give the blower higher pressure. When the open tube speaks its fundamental tone the air particles at the open ends oscillate "out and in" (antinode or point of greatest motion) while the particles at the mid-point of the tube remain stationary, being alternately compressed and expanded (node or point of least motion). This is like a coil spring held stationary at the mid-point and free to oscillate in opposite directions at the ends.

The fundamental tone of the tube closed at one end as well as the overtones of the closed tube were obtained in the same manner as in the case of the open tube by holding the thumb over one end.

The glass tube was used also to obtain the musical scale and to play a simple melody by holding the tube and blower together in one hand while moving it up and down in a jar of water as it was blown. The proper tone positions were marked on the tube with a file. Weird variable pitches were obtained by quickly raising and lowering the tube in the water of the jar while it was blown.

The phenomenon of resonance was strikingly illustrated with the air-blower by "unhorsing the rider" with vibrating air columns. Two 1-quart pickle jars or two large-size measuring cylinders having air columns of the same natural frequency were required for this experiment (Figure 2). The one jar was used to produce its fundamental tone; the other, at a distance of 50 or more feet, was excited into resonance and bumped off a paper rider.

The dimensions of the jars were: height, 7¾ in.; diameter of mouth, 2¼ in.; inside diameter of jar, 3⅛ in.

One jar was placed on the demonstration table inclined at an angle so that a strip of paper properly formed and placed across the mouth of the jar was about to slide off but just did not slide. The paper used was smooth writing paper of medium rigidity, 1½ in. wide by 3½ in. long. It was folded lengthwise and opened to a 90-degree angle,

the wings slightly curved as shown in the diagram. This rider was placed on the upper edge of the jar so that it was just at the point of slipping off.

Now when the second jar was carried to a distant point in the room and its tone sounded with the blower, sympathetic vibrations were excited in the rider's jar of sufficient magnitude to kick the rider off. The tone from a smaller jar or from a larger one did not disturb the rider. For con-

FIGURE 2.—Resonance Jar and Rider

venience a thread two feet long was tied to one end of the rider and fastened to the jar to prevent the rider from dropping to the floor. With proper conditions it was not difficult to make this simple apparatus so sensitive that the rider was dislodged at a distance of 100 feet.

If a piano is available in the room one particular piano tone will bump the rider off. Other piano tones will not disturb it unless their overtones synchronize with the jar tone or unless an overtone of the jar synchronizes with the piano tone. The particular piano tone required for this one-quart jar was F above Middle C or approximately 350 v.p.s. A person may give a vocal command to the rider to fall. It obeys if the voice is pitched in F; otherwise the command is ignored.

The musical tone of a bumble-bee's wings is approximately 160 v.p.s. When I was a boy in fighting bumble-bees to secure their honey and wax we used as weapons a pair of shingles. This gave the bees a fighting chance at least. After I had been stung in the joust a farmer told me that if I should place a gallon jug containing some water near the nest the bees would become angered at the sound in the jug and drown themselves. I tried the experiment with partial success; but I did not realize then that the correct amount of air above the water was the important element in the test. If I had understood the principle of resonance I would have blown across the mouth of the jug to determine the best air volume to imitate and to irritate the bees. I have on the lecture-table a gallon jug which contains the proper amount of air above the water to synchronize with the hum of the bees, 160 v.p.s. Some other insects which we may readily imitate with bottles are: the honey-bee, 384 v.p.s.; the house-fly, 684 v.p.s., and the mosquito, 960 v.p.s.

The long ears of animals are resonators as well as direction finders. They serve to amplify many tones that are useful in securing food and in protection from enemies. One may prove this resonator effect by holding a glass tube 12 in. long by 1 in. inside diameter against the ear while striking successively the keys of the piano. It is surprising how many tones are perceptibly amplified. A wide-mouth bottle held near the ear and properly inclined amplifies noticeably the tone of its own natural frequency. The small tube leading into the human ear is said to amplify tones of the higher pitches. The human external ear, however, has degenerated to the extent of losing both the resonating function and the ability to move the ear back and forth. Huxley concludes that, while it is true that a man can hear just as well today with his outer ears cut off, our ancestors of the dis-

tant past were not only able to move their ears but their ears were longer than ours and more pointed. The muscles which once moved the ears are still present in degenerated form, and occasionally one sees a human ear with the vestiges of the ancestral tip.

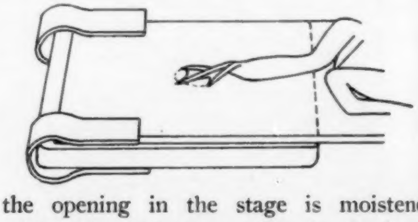
We are reminded also of the amplification of faint sounds by resonance in a large seashell held near the ear—the mysterious roar of the sea.

To explain the human voice—pleasing or otherwise—we need to bear in mind that we speak or sing or cry by virtue of vibrating air columns, that is by resonance. The diminutive vocal chords would be powerless as a source of sound without the help of the air columns of the mouth, nose, throat and chest to supply both volume and tone quality. The vocal chords merely act as exciters or energizers of air columns in much the same manner as a tuning-fork energizes the air column in the familiar laboratory resonance experiment. While the strength and versatility of the two little muscular membranes which stretch across the top of the larynx should not be underestimated they function simply as a reed instrument. In this respect the vocal chords serve the same purpose as the cruder motions and tensions of the musician's lips against the mouthpiece of the bugle, the trombone and the horns.

In demonstrating the resonance experiment of kicking the rider off the bottle we should not lose the opportunity of calling to the attention of the class the close analogy between this experiment and the challenging mystery of the radio. The bottle and blower represent the sending station, an electrically oscillating source. The air waves of the experiment represent the electromagnetic radio waves. The second bottle and rider represent the tuned oscillating circuits of the receiving instrument.

FREDERICK F. GOOD,
Edgewater, N. J.

A new method for mounting a frog for demonstrating circulation in the web.—A pithed or anesthetised frog is mounted on a glass plate that has been clamped to a microscope stage. The area over



the opening in the stage is moistened with a drop of water. One leg is drawn back and the foot spread out over the opening in the stage as shown in the figure. The foot will remain in position indefinitely in a pithed frog or as long as an adequate degree of anesthesia is maintained. Frogs wrapped in moistened cloth and neither pithed nor anesthetised are not entirely satisfactory for periods of over ten minutes although they have been observed for as long as thirty minutes without movement of the foot. This preparation is simple, rapidly made, avoids overstretching of the web, and obtains as flat a field as possible.

BERTIL G. ANDERSON,
Biological Laboratory,
Western Reserve University

Editorials and Educational News

SCIENCE IN GENERAL EDUCATION

Science has done three great things for mankind and these things have created a new world. (1) It has discovered laws of nature the application of which to the problems of living has banished some diseases, curbed others and has doubled the length of life in a generation; has created new and more productive types of plants and animals; has revolutionized manufacture, transportation and communication. In a word, the application of these laws has enabled man to adjust himself more and more successfully to the world in which he lives. (2) Science has developed in man a new attitude of mind—the scientific attitude—and greater skill in thinking because it has forced him to become conscious of the steps in the process and the safeguards that must be observed to avoid errors. (3) It has modified his emotional reactions—freed him from superstitions and fears, increased his reverence and humility, strengthened his desires to live in accord with the laws of creation and the beauty everywhere revealed.

What science has done for mankind, science instruction in a general education should do for the individual. It should lead him to such a comprehension of the most frequently needed laws as will enable him to apply them to his problems in life and so better adjust himself to his constantly changing world. Science instruction should help transform the careless thinker into a critical, accurate thinker. It should help establish desirable emotionalized standards. These are the major goals. The more specific objectives are to be listed as the particular laws to be mastered, the elements and safeguards of thinking, skill in the use of which is to be acquired, the desirable emotionalized standards to be achieved.

These must each be allotted to its proper place in the curriculum from kindergarten to college. Their placement can only be determined by experimental studies. Miss Murdoch (Masters thesis, The University of Chicago) undertook to teach the law of the conservation of energy from eighth grade down. Of course it could be memorized in any grade. But mastery so it could be applied to problems of the sort that arise in the life of the pupil was found impossible below grade eight and at that level it was still difficult. At present we must guess at the proper grade placement of these elements of the curriculum or be guided by personal experience. A host of experimental studies is needed to find the proper grade level for the laws, elements of thinking and emotionalized standards.

Further, we must analyze these laws, skills, attitudes to see what concepts are required to grasp each and what pupil experiences will best clarify the needed concepts. These are the still more specific objectives of particular lessons or groups of lessons. Thus, if the law of the conservation of energy is to be mastered some time the pupil must then know by experience what is meant by energy, the transformation of energy, that magnetism, electricity, heat, etcetera, are forms of energy. The science of the elementary school can give such experiences. Pupils can feel the pull of a magnet, crank a dynamo, see mechanical motion change to electricity. Elementary science can help establish by precept and example skill in thinking, proper attitudes and habits, all of which fall in line with the major goals.

By wise planning the science instruction

can be made into a unified whole, each part worth while in itself but also contributing to a mastery of laws, acquisition of skills and setting up emotionalized standards. The teacher can not "learn 'em"; but he can teach them how to learn.

ELLIOT R. DOWNING

THE TASK OF THE SCIENCE TEACHER TODAY

These are stock-taking days. A new year is ahead of us. That was an arresting thought expressed by Professor Arthur Compton in his Christmas message, that we shall probably look back upon the years 1871 to 1914 as the Golden Age, both of science and of democracy.

We who are interested in the study and the teaching of science in America, realize the close of that Golden Age most keenly through a knowledge of what happened to research abroad when the Great War struck. Its fatal grip laid us low here, too, but only for a time. Democracy seems now to have left Europe completely. Can science really thrive there without it? One of the dictators was quoted recently as saying that a scientist in that country must be a good fascist first, before he is a chemist or a biologist!

True statesmen throughout the world's history have agreed with William Penn that the best government is the least government. It was this conviction that inspired his Commonwealth of Pennsylvania. It was this conviction that just a hundred and fifty years ago found its way into our national Constitution. It is this conviction that has made Britain the most successful colonizer in history.

The genius of democracy and the genius of science, as Compton points out, go hand in hand in their search for Truth. Dictatorship on the other hand sets up leading strings, regimentation, repression of Truth.

What are we as teachers of science to do about this? Fundamentally we know that the seed of science is the creative spirit of man. This alone has built our present extensive control of our environment. We can but teach our pupils this, and point out that it is only the Truth that makes men free. No program of government then should be built up that will curb man's creative spirit in its search for Truth, and thus in his further control of his environment.

So much for our attitude in the classroom toward research. But is there another duty that we owe to our profession?

Few of our pupils will become researchers, and few will have a direct hand in the making of laws for our statute books. All will be voters, however, and because of our teaching should be better informed on such local and national policies as conservation of natural resources. Yet important as this guidance and inspiration is to them in the discharge of their functions as citizens, still it does not complete our duty to our pupils. Indeed, a far greater duty yet remains. For beside and beyond the few who will devote themselves to research in science, and the few who will make our laws, and beyond the weeks of a campaign and the day of an election, stretch out the whole lives of all of our pupils. What are we doing for these? Are we seeing to it that in some measure every one of them is getting daily an appreciation of the beauty and grandeur of Nature's forces and resources —and getting this feeling of appreciation in such attitudes and clothed in such untechnical terminology that it will "stick to his ribs" through the long days to come, be they full of work and worry, of welcome leisure, or of forced retirement on meager income in this age of new technologies which spring up overnight?

For a certain percentage of the boys and girls in our classrooms today it is a grave question whether labor in industry will supply them a livelihood. Indeed, with increasing perfection of labor-saving machines, the chances are growing that it will not.

Are we introducing these, along with their fellow students, to the good earth as

the source of man's elemental needs, physical and to an amazing degree, mental and spiritual? The race has trod that road, built up its stamina along the way, and science is and must always be, the interpreter of this heritage of appreciation, as well as pathfinder, and guide into new controls of Nature's forces and resources.

EDW. E. WILDMAN,
Director of Science Education,
Philadelphia, Pa.

HELP WANTED—FOR JUNIOR-HIGH-SCHOOL SCIENCE

The rapid growth in enrollment in general science is one of the outstanding characteristics of science education of this generation. Many educational leaders seem to take it for granted that the struggle for adequate science instruction at the junior-high-school level has been won. Far from it! Any person who visits schools generally learns promptly that only a beginning has been made.

The standards of certification for science teachers in the various states are so low that only a small minority of junior-high-school teachers have an adequate scientific training for the difficult work of teaching science in grades seven, eight, and nine. To correct this great deficiency higher institutions of learning should organize extension and summer-school courses for these teachers. Boards of education should make it possible for them to improve their training for public service. State departments of education should raise the standards for secondary school certificates. Teachers in this field are too infrequently found who have had enough basic training in biology, physics, chemistry, astronomy and geology to serve as real leaders for junior-high-school boys and girls.

The work in general science is still concentrated in grade nine. In only a few states is science generally taught in grades seven and eight. The school administrator is the chief obstacle in this situation. We will have to find a way to educate these school executives. Schools of education need to organize a required course to acquaint administrators with the educational goals and present-day practices in the various special fields of secondary education.

The general science teacher has too many classes and these classes are too large in the majority of schools, especially the large high schools. National and local organizations should study this problem to find a means of relief. The individual teacher will be unable to solve this problem alone. Many teachers have given up the fight, already, as hopeless.

The variety of topics now in use in a given grade is appalling. Surely after twenty-five years of trial and error in grade placement and some slight amount of educational research in this field leaders in science education and school officials ought to come to some agreement on a few topics that might be useful in a given grade or for all grades of the junior high school.

General science is, primarily, a textbook course in most schools. Teachers lack adequate science furniture. They have little or no suitable apparatus and equipment that is useful for present-day instruction, duly a few administrators have any conception of their responsibilities in this connection. Organizations of science teachers should do something at once to correct this great educational deficiency. A nation that uses over twenty billion gallons of gasoline in a single depression year ought to be able to provide a small sum of money for scientific apparatus for each of its schools.

The science texts and reference books are too old and too few in number. It is a rare school that has enough up-to-date texts, reference books, and popular science magazines to teach junior-high-school science properly.

General-science teachers should be given a single room in which to teach. The wandering science teacher will never be able to make a success of his work. The great variety of subjects taught by these teachers

needs to be reduced by principals. Visual aids are urgently needed and rooms should be equipped with dark shades, a screen for projection, and suitable electrical connections for lanterns.

There is great need for alternative methods of instruction. The assignment-recitation type of teaching is still in use in the majority of schools. State associations of science teachers should hold regional meetings at which experienced teachers would demonstrate modern methods of classroom work.

Many other improvements are needed in general-science instruction—the greatest of these is a marked increase in salary for the well-trained, interested teacher who has a real professional attitude in his work. He is the salt of the earth and a blessing to boys and girls in the junior-high-school. What can local and national organizations do to make him believe that his work is needed in a democracy?

EARL R. GLENN,
New Jersey State Teachers College at Montclair

PROGRAM OF THE TENTH ANNUAL MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

NEW ORLEANS, LOUISIANA
FEBRUARY 20 TO 23, 1937

Headquarters: Hotel St. Charles

Executive Committee
W. G. WHITMAN, *President*
IRA C. DAVIS, *Vice President*
S. RALPH POWERS, *Secretary-Treasurer*
HANOR WEBB
GERALD S. CRAIG

Saturday, February 20, 1937
2:00 P. M.
Joint Meeting with National Council on Elementary Science.
Hotel St. Charles—Room A.
Helen Dolman Blough—*Presiding*

2:00—*The Place of Experimentation in the Elementary Science Program.*
Francis D. Curtis, University of Michigan, Ann Harbor, Michigan.

2:30—*The Contribution of Elementary Science to International Understanding.*
Gerald S. Craig, Teachers College, Columbia University, New York, New York.

3:00—*Demonstration of Sound Films. Overcoming Limitations to Learning.*
Erpi Picture Consultants, New York, New York.

4:00—*Informal Discussion.*

4:30—*Business Meeting of the N. C. E. S. (for Members only).*

6:00—*Joint Dinner Meeting.*
Hunt Room, St. Charles Hotel.

Sunday Evening, February 21, 1937
Hotel St. Charles—Room B.
Dinner Meeting 6:30 P. M.—For Members Only.
W. G. Whitman, *Presiding*

Monday, February 22, 1937
9:00 A. M.
Association of Commerce Building—Room 300
Joint Meeting with the Society for Curriculum Study.
W. G. Whitman, *Presiding*

9:00—*Business Meeting.*
A. Report of the Nominating Committee and Election of Officers.
B. Unfinished Business.

9:30—*Report of the Committee of Five.*
Ralph K. Watkins, *Chairman.*

10:15—*Panel Discussion of the Preliminary Report of the Science Committee to the Commission on Secondary School Curriculum of the Progressive Education Association.*
Otis W. Caldwell, Boyce Thompson Institute, Yonkers, New York, *Chairman of the Panel.*
Members of the Panel:
E. R. Bayles, School of Education, University of Kansas, Lawrence, Kansas.
C. L. Cushman, Department of Research and Curriculum, Denver Public Schools, Denver, Colorado.
R. J. Havighurst, General Education Board, New York, New York.
C. J. Pieper, School of Education, New York University, New York, New York.
S. R. Powers, Teachers College, Columbia University, New York, New York.
R. K. Watkins, School of Education, University of Missouri, Columbus, Missouri.

Tuesday, February 23, 1937
9:15 A. M.
Association of Commerce Building—Room 300
Joint Meeting of the American Educational Research Association and The National Association for Research in Science Teaching.
W. G. Whitman, *Presiding*

9:15—*A Study of the Vocabulary Suitable to High-School Science.*
Francis D. Curtis, School of Education, University of Michigan, Ann Arbor, Michigan.

9:45—*Science Claims in Magazine Advertising.* Ralph K. Watkins, School of Education, University of Missouri, Columbus, Missouri.

10:15—*The Selection, Organization and Evaluation of Localities Available for Unspecialized Field Work in Earth Science in New York City Region.* Herbert J. Arnold, Teachers College, Columbia University, New York, New York.

10:45—*The Implication of Curriculum Research for Science Teaching.* Archer W. Hurd, School of Education, University of Minnesota, Minneapolis, Minn.

11:15—*The Cooperative Science Tests in Philadelphia Schools: Results and Interpretations.* Edward E. Wildman, Director of Science Education, and Philip A. Boyer, Director Research and Results, Philadelphia, Pennsylvania.

Wednesday, February 24, 1937
2:00 P. M.

Members of the organization are invited to attend the following meeting of the National Association of College Teachers of Education.

American Legion Club

William S. Gray, University of Chicago, *Presiding*

Presentation of the 1937 Yearbook:

The Use of Background in the Interpretation of Educational Issues.
Charles F. Arrowood, University of Texas, *Chairman of the Yearbook Committee.*

Contributors on Materials on Science:
S. R. Powers, Professor of Natural Sciences, Teachers College, Columbia University.
Herbert C. Elfman, Assistant Professor of Zoology, Columbia University.
Leslie C. Dunn, Professor of Zoology, Columbia University.
George W. Hartmann, Associate Professor of Education, Teachers College, Columbia University.
Duane Roller, Professor of Physics, University of Oklahoma.

Panel Discussion: Making Background Materials Available for the Interpretation of Educational Issues:
Philip W. L. Cox, New York University, *Chairman.*
Thomas E. Benner, University of Illinois.
A. T. Brogan, University of Illinois.
John S. Brubacker, Yale University.
Newton Edwards, University of Chicago.
Charles H. Judd, University of Chicago.
Grayson N. Kefauver, Stanford University.
Edgar W. Knight, University of North Carolina.
Charles W. Pipkin, Louisiana State University.
S. Ralph Powers, Teachers College, Columbia University.
Thomas Woody, University of Pennsylvania.

CURRICULUM JOURNAL BECOMES A PRINTED PUBLICATION

The *Curriculum Journal,* official organ of the Society for Curriculum Study, which began seven years ago as a mimeographed bulletin, became a printed publication with the issuance of the January, 1937, number, the first in Volume 8. Besides articles and other usual departments of an educational journal, the *Curriculum Journal* prints abstracts of curriculum research and listings of recent courses of study. Its department of news notes is a thorough coverage of important curriculum projects throughout the United States. The *Journal* is printed in two columns and is in keeping with the present trend toward small magazines. The January number includes articles by David Snedden, Goodwin Watson, C. W. Knudsen, Edgar M. Draper, and A. V. Overn. The *Journal* is edited by Henry Harap, who is the executive secretary of the Society for Curriculum Study. The publication office is located at the Bureau of Educational Research, Ohio State University, Columbus, Ohio. The subscription price is $2.50 a year.

Abstracts

GENERAL EDUCATION

RATHS, LOUIS. "Basis for Comprehensive Evaluation." *Educational Research Bulletin* 15: 220–224; November 11, 1936.

The instruments now available or being devised for evaluating eight significant aspects of behavior in thirty high schools cooperating in an eight-year study to improve secondary education operating under grants from the General Education Board and the Carnegie Corporation as discussed in terms of objectives to be measured and listed under eight headings as follows: "Thinking"; "Interests, Aims and Purposes"; "Attitudes"; "Study Skills and Work Habits"; "Social Adjustments"; "Creativeness"; "Functional Information, including Vocabulary," and "A Functional Social Philosophy." Ninety-nine separate instruments are listed. —C.M.P.

Symposium. "The American High School." *Progressive Education* 12: 433–488; November, 1935.

All teachers in secondary schools will be interested in this number of *Progressive Education*, which is devoted exclusively to the American high school. An overview of this number may "Toward School-College Cooperation," by Milford M. Aikin; "The Work of the Committee on Reports and Records," by Eugene R. Smith; "Equipping Young People to Read and Write," by John A. Lester; "A College Dean Looks at the Eight-Year Experiment," by Max McConn; "Social Studies and the Correlated Courses," by Margaret A. Koch; "A Unified Course in Creative Arts," by Alma Bowen; "Disregarding Tradition in the Science Room," by Earl Goudey; "Correlating Geometry and History," by Ruth B. Sanger; "Record Making in an Experimental School," by H. H. Giles; "A Basis for a New Secondary Curriculum," by V. T. Thayer, and "A Progress Report on the Study of Adolescents," by Caroline B. Zachry.
—F.G.B.

Symposium. "Teacher Education Number." *Education* 56: 193–251; December, 1935.

This number of *Education* is of special interest to all who are engaged in the education of teachers. The following titles of articles summarize the content of the number:

"A Forward Look to Teacher Education," by Hermann Cooper; "Henry Barnard and Teacher Training," by Anna Lou Blair; "Horace Mann and the Normal School," by E. I. F. Williams; "Edward Austin Sheldon and the Oswego Normal School," by Richard K. Piez; "A Century of Teacher Training in New York," by William Marshall French; "The Teachers' Reading Circle as an Agency in the Education of Teachers," by Jesse B. Johnson; "The In-Service Training of Teachers," by Harvey S. Gruver; "What an Administrator Expects of the New Teacher for Guidance," by J. Allan Hicks; "Inaugurating the Language Arts for Social Purposes," by Walter V. Kaulfers and Holland D. Roberts; "Three Methods of Teaching Design," by William S. Rusk, and "Strengths and Weaknesses of Student Teachers," by W. W. Ludeman.
—F.G.B.

Symposium. "Education of Teachers in New College." *Teachers College Record* 38: 1–73; October, 1936.

This issue of *Teachers College Record* is devoted to New College—an experimental college for the training of teachers, started in September 1, 1932. There is no other college in the world quite like it. An interesting history of the first four years is included, followed by an appraisal of (1) Curriculum Content and Organization, (2) Directed Teaching and (3) Selective Admission and Promotion. A brief statement of plans for the next four years concludes the symposium. —C.M.P.

GILLESPIE, ALEX S. "Biology in the Education of New Germany." *The School Science Review* 17: 398–410; March, 1936.

The political revolution in Germany has been accompanied by an amazing mental revolution. Three types of secondary schools exist, each with a special emphasis and with a minimum of overlapping in subject-matter emphasis: (1) Gymnasium for classical education; (2) Realgymnasium for modern languages and mathematics; and (3) Oberrealschule for scientific training. Biology is especially emphasized and all boys have to take it during the last two years. The course is about equally divided between botany and zoology, with natural history being emphasized in the lower forms. Health and physical fitness are emphasized. "So much is thought of Biology in the mental equipment of New Germany that instruction is not confined to any special section of the community or limited to the schools in the hope that it will be utilized practically by the next generation. It is brought before the people by the means of public lectures and exhibits—Huge models and large conspicuous diagrams were made with an exactness and a perfection technique which make the visitor gasp—There was an elaborate bell-tower containing a gigantic hour glass,

which turned every five minutes and indicated at the same time the country's death rate—seven in five minutes. At the same time 9 bells chimed in order to announce the birth of 9 children—There is no doubt that the most novel and educative exhibit was the "Glass Man"—a life size model of the complete anatomy of a man in colored glass. It occupied a room to itself with space all round for a large audience. Lights were dimmed and the figure talked. It gave a lecture on its own physiology and anatomy, and as each part or system was mentioned, it was lit up from inside." Another novel feature of the biological education is the "Country Year." All children living in towns will, in the future, at the end of their school periods, spend a year in the country. In 1934, 20,000 children of industrial cities were distributed over 500 country "homes" in country districts of Central Germany. In 1935 this number was increased to 31,000 distributed to 600 "homes." Biology in its agricultural relationships is here emphasized as a part of the planned daily routine.

—C.M.P.

SCIENCE EDUCATION

SCHLESINGER, H. I. "Important Criteria in Evaluating Laboratory Work." *Education* 56: 393–396; March, 1936.

In this article, Dr. Schlesinger analyzes the laboratory situation and concludes that the right kind of laboratory work should not be abandoned. He points out that as the number of students increased, the work in science laboratories gradually lost its original meaning. Formerly, science was reserved for those who required it in their professional work. Today, it "has become a part of the general education of everyone who desires acquaintance with important modern currents of thought and with factors which play an important role in our economic and social development." He says that it is the business of education to "provide training in how and what to see and in translating observation and thought into well-considered action." Laboratory work as it is now organized does not, in general, pay sufficient attention to these general objectives and does not provide opportunity for the student "to develop his ability to analyze a situation and to devise procedure for meeting it." The author says that "the criteria for the success of an elementary laboratory course should be sought in the students' increasing accuracy of observation, increasing ability to use data and knowledge in drawing conclusions, and increasing independence in planning tests to check the conclusions drawn."

The article is concluded by a description of an experiment which clarifies the objectives and criteria advocated and more nearly meets the objectives of training students "to see, to think, and to act." —F.G.B.

Symposium. "Science Number." *Education* 56: 385–448; March, 1936.

This issue of *Education* is of particular interest to science teachers. The following titles indicate the topics considered:

"General Science as Portrayed on Stamps," by Harold F. Schaeffer; "Outcomes of the Cleveland Studies in Science," by Mary Melrose; "Important Criteria in Evaluating Laboratory Work," by H. I. Schlesinger; "Reorganization of High-School Science Teaching—Laboratory or Library?" by J. T. Giles; "A State-Wide Program of Science Education in Elementary Schools," by Helen Heffernan; "What Should the High School Science Teacher Know?" by Ralph K. Watkins; "Science Education in the C.C.C.," by Carl G. Campbell; "Discipline in the Science Classroom and Laboratory," by Elizabeth Segar; "Nature Education: Social and Recreational," by William Gould Vinal; "The Resourceful Science Teacher," by Guy M. Lisk; "Opportunities for Science Study Abroad," by Lois Meier Shoemaker; "Why Visual Materials Appeal in Science," by J. M. Stackhouse; "Some Observations on Testing Procedures in Chemistry," by Ralph K. Carleton; "A Science Night Program," by Robert Collier, Jr.; "How to Make Committees Function," by Ira C. Davis; "Comments on the Controversy Between Nature Study and Elementary School Science," by E. Lawrence Palmer, and "Special Activities of Science Students," by Edith R. Force.

In addition to these articles, stimulating editorials by Otis W. Caldwell, H. S. Caswell, and S. C. Garrison are included. Hanor A. Webb has contributed a list of important associations of science teachers and of outstanding professional magazines. —F.G.B.

WATKINS, RALPH K. "What Should the High-school Science Teacher Know?" *Education* 56: 405–407; March, 1963.

The answer Watkins gives to the puzzling problem "What should high school science teachers know?" may be summarized in the following statements:

"(1) The high-school science teacher must know science as a general field; (2) The high-school science teacher should have some degree of specialization in one of the fields of science; (3) The high-school science teacher needs the knowledge that has been developed in the field of professional education; (4) The well-trained science teacher must become aqcuainted with the professional literature of his craft; (5) The high-school science teacher should know the science textbooks developed for use in the secondary schools; (6) The science teacher must have a working knowledge of the equipment needed for his work; (7) The successful science teacher must become acquainted with many of the familiar applications of

the science which he teaches; (8) To continue a successful career, the teacher of science should keep up with current literature of science."

—F.G.B.

BELTRÁN, ENRIQUE. "The Place of the Biological Sciences in Educational Programs." *Progressive Education* 13: 92–97; February, 1936.

This paper was read at the conference held in Mexico City during the summer of 1935 by the North American Section of the New Education Fellowship. Dr. Beltrán, a member of the Institute of Socialistic Orientation and a Professor in the Teachers College, considers the part which "the biological sciences should play in the programs of elementary, secondary, and normal schools, and in higher institutions of teacher training." He summarizes his discussion in this way: "we may say that the teaching of the biological sciences should occupy one of the most important places at all levels of education; in the elementary and secondary schools to prepare the pupil to understand nature and how it benefits society; in the normal schools to prepare future teachers to understand young children and to help them understand nature; and in the pedagogical institute to prepare teachers of biology in the secondary and normal schools." —F.G.B.

ELEMENTARY SCIENCE

MELROSE, MARY. "Outcomes of the Cleveland Studies in Science." *Education* 56: 389–392; March, 1936.

This article is concerned with the development of work in elementary science in the Public Schools of Cleveland, Ohio, through a curriculum center school in science. Miss Melrose presents in a clear concise account, the procedures used in developing the science course in Doan School with the pupil as the dominating factor in the curriculum work. She tells clearly how the science program developed and was put into operation in the elementary schools of Cleveland. —F.G.B.

HEFFERNAN, HELEN. "A State-Wide Program of Science Education in Elementary Schools." *Education* 56: 400–403; March, 1936.

The author discusses the state-wide program in science education in elementary schools that is being developed in California. In 1932, "A Suggested Course of Study in Science in Elementary Schools" was published. In August, 1934, the State Department of Education began the publication of a series of bulletins entitled, "The Science Guides for Elementary Schools." Members of the science departments of each of the State Colleges for the training of teachers cooperate in the preparation of these monthly bulletins. The author states that "Plans are now being made for preliminary experimental use of the materials before the bulletins are published in order (1) to test the interest of the materials in classroom situations and (2) to provide suggestions for teachers concerning activities which grow out of units of work in which the material is used."

—F.G.B.

HAHN, H. H. "Why Failures in the Study of Geography?" *Journal of Geography* 35: 225–234; September, 1936.

The following reasons (based on a study of 283,000 answers on a geography scale) are enumerated as the cause of failures in geography: (1) Lack of reading ability essential to the successful study of geography; (2) Lack of concrete geographical experience; (3) Not in the habit of using the information already acquired in the further mastery of the subject; (4) Failure to master the different types of symbols employed in geography; (5) Inability to interpret maps for the different purposes for which they are used in texts; (6) Lack of ability to locate places, peoples, and activities; (7) Lack of productive imagination; (8) Lack of ability to discover relationships, and (9) Lack of ability to use relationships.

—C.M.P.

STAUFFER, M. K. "Seed Dissemination." *The Grade Teacher* 54: 18, 76; September, 1936.

An illustrated nature study lesson on the kind of seeds and their dissemination: sling seeds, hooked seeds, wind-blown seeds, berry seeds and seed pods and burs. —C.M.P.

TRAY, ROSEMARY. "Rubber." *The Grade Teacher* 54: 22, 77; September, 1936.

An illustrated outline for the study of the rubber tree and its products. —C.M.P.

MOORE, GERTRUDE. "Squirrels." *The Grade Teacher* 54: 16, 70; October, 1936.

This is an excellent illustrated unit on an animal familiar to many children. —C.M.P.

WHARTON, ELEANOR. "Meat Packing." *The Grade Teacher* 54: 18–19, 66; October, 1936.

This is an integrated unit on the meat packing industry. Excellent illustrations. —C.M.P.

CUMBERLAND, MARYELLEN. "Soils." *The Grade Teacher* 54: 16–17, 53; November, 1936.

Soil erosion and conservation are stressed in this illustrated elementary science unit, including an outline of study. —C.M.P.

PALMER E. LAURENS. "Spiders and Their Kin." *Cornell Rural School Leaflet* 30: 3–32; November, 1936.

This leaflet discusses. (1) what are spiders and their kin? (2) how spiders travel; (3) how spiders capture their food; (4) how spiders grow; (5) how spiders protect themselves, and (6) what good are spiders. —C.M.P.

WRIGHT, MARY H. "Coal and Its By-Products." *The Grade Teacher* 64: 14–15; January, 1937.

This is an integrated science-geography unit for the intermediate grades. Illustrated. —C.M.P.

BENNETT, ERCELLE. "A Unit on Astronomy." *The Instructor* 46: 15, 69; January, 1937.

This is a sixth-grade unit on astronomy including: (1) Understandings; (2) Emotionalized Attitudes; (3) Special Abilities; (4) Content; (5) Major Activities, and (6) Test. —C.M.P.

BANCROFT, IDA E. "A Study of Evergreen Trees." *The Instructor* 46: 25, 64; January, 1937.

This is a third-grade unit in elementary science. Aims, outline of subject matter and means of developing the unit are included. —C.M.P.

JULIAN, KATHERINE L. "Learning About Cloth." *The Instructor* 46: 44–54, 65, 71; January, 1937.

Suggested procedure for each of the following divisions is included: (1) Primary grades; (2) Intermediate grades, and (3) Upper grades. Each procedure includes: (1) General objectives; (2) Titles for supplementary lessons; (3) Desired attitudes; (4) Abilities to be developed; (5) Activities; (6) Bibliography, and (7) Test. An illustrative unit is included for each of the three levels: (1) Primary grades, "What Cloth is Made Of"; (2) Intermediate grades, "The Manufacture of Cloth," and (3) Upper grades, "The Importance of Cloht in International Trade." —C.M.P.

SECONDARY SCIENCE

Symposium. "Communication"; "Power." *Building America* 1: 1–27, 1–27; February, March, 1936.

These two issues of *Building America* are given over to a photographic interpretation of communication and power in modern industrial, economic, and social life. Each number contains much excellent material for the general-science and physics classes. —C.M.P.

BABCOCK, RUSSEL B. "A Seventh Grade Course in Sex Education." *Progressive Education* 13: 374–382; May, 1936.

In this article, the author describes the purposes, organization, and procedure in a seventh grade course in sex education as taught in the schools of Winnetka, Illinois. This course "is a part of the course in biology and is a required one, though it may be omitted from the child's program provided the parent requests this of the superintendent and gives adequate reasons for its omission." The girls are taught by a woman instructor and the boys by a man.

The purpose of the course, "is to help boys and girls obtain a healthy and intelligent attitude towards sex. The achievement of this goal is dependent upon two things: first, the teacher's attitude with the students, and second, the learning of certain essential facts by the students." —F.G.B.

SCHAEFFER, HAROLD F. "General Science as Portrayed on Stamps." *Education* 56: 385–388; March, 1936.

The author points the way to an interesting hobby which may be stimulated by general science and, at the same time, may serve as a medium for teaching science. He states that the first real person about whom history records anything of importance was an artist and scientist, Imhotep, who lived about three thousand years before the Christian era. Imhotep was honored by having his picture placed on an Egyptian stamp. Twenty-five centuries later the crown and staff of Aesculapius, a great Greek student of medicine, was put on a stamp. From this time on, stamps have been issued relating to phases of medicine, agriculture, zoology, botany, physics, chemistry, and astronomy. —F.G.B.

OPPE, GRETA. "The Use of Chemical History in the High School." *Journal of Chemical Education* 13: 412–414; September, 1936.

Describes a unit in chemistry which purports to sketch in brief outline the development of chemistry from ancient times to the present. References are given and the author reports great success in high-school chemistry classes with this type of work which seems to make chemistry and its ideals meaningful to boys and girls. An innovation is the modelling of famous persons in chemical history out of soap, wood and plaster of Paris. —V.H.N.

PALMER, E. LAURENCE. "Teachers' Number." *Cornell Rural School Leaflet.* 30: 6–60; September, 1936.

Particular attention in this leaflet is given to science in grades seven to ten. The following realms are considered: (1) space measurement and mastery; (2) food problems; (3) energy studies; (4) weight; (5) sound; (6) magnetism and electricity; (7) energy transfer; (8) origins and ancestry; (9) instinct or intelligence; (10) protection; (11) physical environment; (12) biological associates; (13) light; (14) heat; (15) molecular nature; (16) chemical nature; (17) cycles and sequences, and (8) balance. —C.M.P.

Symposium. "Special Science Club Number." *The Science Leaflet* 10: 1–35; September 24, 1936.

This special science club number discusses: "Organizing the science club, including a typical constitution"; "science club programs"; "planning science demonstrations," and "the Student Science Clubs of America and some of their activities." —C.M.P.

BAGGALEY, E. J. "The School Science Exhibition." *The School Science Review* 18: 2–8, 185–191; October, December, 1936.

The author makes a plea for more school science exhibitions, but insists that the exhibitions play a useful part in the science teaching of the school rather than being designed merely to please visitors. Suggested activities and exhibitions are listed. —C.M.P.

Symposium. "Human Biology." *The Science Leaflet* 10: 105–112, 149–156, 185–190, 231–234, 258–265; October 1, 8, 15, 22, 29, 1936.

This series of articles discusses the following phases of human biology: (1) The human race at present; (2) The human race in the past; (3) The structure of man; (4) How man works, and (5) How man survives. —C.M.P.

BAKER, ROSS A. "Some Trends in Chemical Education." *Report of the New England Association of Chemistry Teachers* 38: 6–19; September, 1936.

Professor Baker believes that future secondary chemistry courses will see more thermo-chemical and electro-chemical experiments and less analytical chemistry. Micro methods will be used to a considerable extent. He lists the following order as the desirable outcome of the introductory cultural chemistry course: (1) the development of a sense of matter—reliance upon the properties of substances which determine their responses to their environment; expectancy of changes which will produce new properties; mastery of the controls which man can exercise over these changes; (2) a vocabulary which will enable the student to intelligently read chemical news in the daily press; (3) sufficient technical knowledge to enable the student to interpret natural phenomena, appreciate the chemical foundations of industry, and to vote intelligently upon such problems as the purification of water, the disposal of waste, air conditioning, and preservation of food, and (4) a vision of the field of chemistry for those who have not yet found themselves, and at the same time a barrier to discourage those who are unfitted to enter the profession. —C.M.P.

COLLEGE SCIENCE

ANIBAL, FRED G., and LEIGHTON, PHILLIP A. "A Plan to Eliminate the Overlapping in High-School and College Science Courses." *Journal of Chemical Education* 13: 437–442; September, 1936.

The source of most of the difficulties attending the articulation of high-school and college science courses lies in that they attempt to meet the needs of those who wish to specialize and of those whose interests are more general at the same time. The solution proposed is to have general courses for all, followed by opportunities for specialization for those who desire it. A plan is proposed which calls for three years of general science in the junior high school; a year of general biological science and a year of general physical science followed by year courses for those who wish them in chemistry, physics, biology or physiology in the senior high school, and an arrangement similar to that for the senior high school in the junior college. In general, the plan calls for election of general courses by all but a few; recognition by the college of the specialized second-level courses in the senior high school as the full equivalent of introductory specialized courses in the college, and the general principle that the proposed general courses will be at least equal in propadeutic value to our present specialized science courses. —V.H.N.

FLOUTZ, VAUGHN W. "An Advanced Course in General Chemistry Based on Scientific Journals." *Journal of Chemical Education* 13: 374–375; August, 1936.

The course here described follows one year of work in college chemistry. It was organized around fourteen topics and all content was taken from the *Journal of Chemical Education, Industrial and Enginering Chemistry, Chemical and Metallurgical Engineering* and *The Science Leaflet*. Students were given definite references on each topic in these journals but were encouraged to find material in other sources. Students made oral reports on certain of the references. It is believed that the course served to acquaint the student with important journals and provided opportunity for training in presenting oral reports. —V.H.N.

JOHNSON, WARREN C. "Special Problems in the Teaching of Chemistry." *Journal of Chemical Education* 13: 423–427; September, 1936.

There are certain problems which are more or less peculiar to the teaching of first-year college chemistry. The author discusses some of these problems including, among others, the order of presentation, the introduction of newer concepts, the segregation of students on the basis of "previous training, ability and future application of chemistry" and the perennial question of the place of laboratory work. In his discussion, the author presents the results of his own experience in a clear and helpful manner. —V.H.N.

VILBRANDT, FRANK C. "Résumé of Chemical Engineering Education in United States." *Journal of Chemical Education* 13: 419–422; September, 1936.

A statistical summary of chemical engineering education is presented from an analysis of catalogues, and a questionnaire sent to 93 colleges and universities. Data are presented on degrees, enrolments, instructors, adequacy of equipment and other facilities, courses offered and graduate studies. —V.H.N.

New Publications

HOYT, VANCE JOSEPH. *Zorra: The Biography of a Gray Fox.* Boston: Lothrop, Lee and Shephard Company, 1933. 125 p. $1.50.

This is the biography of a gray fox which the author says was the most intelligent, lovable, and interesting pet he has ever known. In addition to having close association with many wild animal pets tamed for the purpose of studying animal behavior, the author has had wide acquaintance with wild animals in their natural homes.

The reader is brought into intimate relation with Zorra through the many stories told about her. At all times, she is wary, sensitive, affectionate, and playful. She never likes to be alone, is always busy, and exhibits a well developed habit of colecting things. Anything she can carry in her mouth is hidden under rugs, pillows, furniture, or in corners of the room. She shows a high degree of intelligence in the quick way in which she learns new tricks. Odors fascinate her, and when on walks with her master, lead her to many obscure trails. This trait often directed her to lairs of foxes, raccoons, and bobcats and gave the author opportunity to secure valuable field data about wild animals denied to many naturalists.

The book is well illustrated by excellent photographs. The story will delight all who are interested in wild animal pets and their habits. It will be enjoyed by adults as well as by children and should find an important place in school and home libraries. —F.G.B.

FATH, EDWARD ARTHUR. *Through The Telescope.* New York: McGraw-Hill Book Company, 1936. 220 p. $2.75.

This book presents what might be called a popularized treatment of astronomy. It is intended for general reading rather than for use as a textbook. The author states "in this volume it shall be our endeavor to make a journey through space by means of our imagination. In the course of an evening we shall accomplish with the mind what we could not accomplish with our bodies in the course of a thousand lifetimes even though we could move with the speed of light. We shall not take the time, in each instance, to show why certain views are held, as this is the function of a textbook. For the most part we shall adapt the role of sightseers rather than of students."

The author has endeavored to tell a connected story which should include the main facts and a few of the more interesting theories of the astronomical field. The author has tried to include "no more than could be read in one evening by a reasonably rapid reader." —E.D.H.

SWINGLE, D. B. *Plant Life.* New York: D. Van Nostrand Company, 1935. 441 p. $3.00.

This is a textbook in college botany. The organization of content is different from other college botany texts. The prevailing tendency is for a morphological approach, the consideration of function being incidental. The author of this text builds much of the work around life processes such as methods of obtaining and utilizing food, adaptation and the ways in which plants perpetuate themselves.

The book is divided into eight parts. Part 1 deals with variations and plant behavior; Part 2 has for its theme, adaptation; Part 3 is devoted to the food problems of plants; part 4 explains how plants grow; part 5 deals with reproduction in plants; part 6 explains scientific classification of plants and describes in detail the various phyla of plants; part 7 deals with the evolution of the plant kingdom, and part 8 shows how plants are interrelated and how many of them are dependent upon other plants and upon animals.

This book for the most part is interestingly written and should be carefully examined by teachers and students of botany. —E.D.H.

DUNLAP, KNIGHT. *Elements of Psychology.* St. Louis: The V. C. Mosby Company, 1936. 499 p. $3.00.

The title of this book is a good indication of its contents. The author presents, in twelve chapters, a comprehensive viewpoint of his conceptions of human psychology beginning with a consideration of the place of psychology in human thinking. He explains the connection between the inner man and the outer world by means of the various sense organs and sets up bases for reactions through a description of bodily mechanisms. Various types of responses to stimuli are discussed at length. These include simple physical responses, perceptual responses; perception of space and time; thought and thought content; feeling and affects; and learning. The three final chapters deal with psychological measurements, individual differences, and maladjustment and readjustment.

The book includes 65 illustrations, a glossary, and an index. The set-up is quite simple, and the transitions from chapter to chapter natural. The style is scholarly but unusually comprehensible. —A.W.H.

FRENCH, GEORGE W. *Photography for the Amateur.* New York: Falk Publishing Company Inc., 1933. 425 p.

This excellent book covers every phase of photography: equipment, cameras, lenses, shut-

ters, taking the picture, developing, and printing. Special chapters are devoted to the troubles usual to the beginner. Other chapters deal with retouching and other special treatments for the negative, enlarging, miniature camera photography and stereoscopic photography. This revision was made by Lloyd L. Snodgrass, a member of the research staff of the Eastman Kodak Company, and is edited by Herbert C. McKay, dean of the New York Institute of Photography.

—O. E. Underhill.

ADAMS, ANSEL. *Making a Photograph.* New York: Studio Publication, 1935. 96 p. $3.50.

This book is intended as helpful and useful to those interested in photography as a means of artistic expression.

There is a short section on equipment and materials including the camera itself, the construction and equipment of a studio, laboratory, and dark room, the finishing room, and photographic materials. The remainder of the book is devoted to the means to be used in producing artistic photographs.

The various methods and processes are illustrated with beautiful photographic prints, not reproductions of photographs. The themes uses are for the most part quite simple.

The book will be found valuable to the amateur photographer, or as part of the library of the high school or college science and art department.

—R.K.W.

MALONEY, T. J. *U. S. Camera, 1936.* New York: William Morrow and Company, 1936. 238 p. $2.90.

This is a collection of the most outstanding American pictures for the year 1936 by some of this country's most important photographers. There is a brief discussion on "Art" by M. F. Agha. The subjects covered by these pictures give one the range into which photography has been introduced. Along with the ordinary pictures there is a section consisting of beautiful color photographs. These represent the height to which color photography has been advanced. The latter part of the book deals with the application of photography to science. In this section are found some of the pictures taken by Capt. Albert W. Stevens, U. S. A. These are photographs taken during the stratosphere flight in November, 1935.

—F. L. Herman.

FRAPRIE, FRANK R. (Editor). *The American Annual of Photography, 1937.* Boston: American Photographic Publishing Co., 1936. 324 p. $1.50.

Those persons who are most interested in photography usually await the new editions of this yearly publication which appears in October of each year and which is probably the best publication of its kind in America today. This year's edition is no exception. The pictures contained in it are of the same high caliber but do not cover as wide a field as usual. As is customary in this publication a wide range of rather technical articles by various authorities is to be found. This year these articles are better than usual. Among the many excellent articles will be found such discussions as "Infra-Red Photography," "Composition by Combination," and "Pinhole Photography." From the few listed it can be seen that a wide variety of interests is included. To those interested in photography professionally or as an amateur this publication will serve as a ready, authoritative reference and guide.

—F. L. Herman.

DMITRI, IVAN. *How to Use Your Candid Camera.* New Yorq: The Studio Publications, Inc., 1936. 135 p. $3.50.

This is a valuable book for anyone interested in taking miniature photographs. Twenty-one pages are devoted to a description of the handling of the Leica camera and the use of different type lenses. The remainder of the book gives fifty-four miniature photographs and full-page enlargements of them. The data are given under which each photograph was taken. The enlargements show the artistic possibilities of photography.

—W.G.W.

PHILLIPS, MARY G., and WRIGHT, JULIA M. *Nature by Seaside and Wayside.* Boston: D. C. Heath and Company, 1936. Series of four books, $0.64 to $0.72 each.

Each book gives an interesting account of appropriate subject matter. Each unit has a general discussion to introduce the unit. This is followed by a discussion of a number of specific topics under the unit heading. Each unit ends with simple tests and often with other suggestions as, "What to do," "Thinking it over," "Some puzzles to solve," and "Finding out something yourself." At the end of each book is a list of "new words" with pronunciation and definition. As the titles suggest, three of the books are on nature study of plants and animals and half of one book takes up astronomy and the earth. The books are illustrated in black and white and in color. They are interestingly written.

Book I. *Some Animals and Their Homes.* 142 pages. Describes the houses of wasps, bees, spiders, crabs, snails, and mollusks.

Book II. *Some Animal Neighbors.* 186 pages. Describes the ant city, house-fly, mosquito, beetle, dragon-fly, earthworm, seaworms, barnacles, jellyfish, and starfish.

Book III. *Plants and Animals.* 244 pages. The following units make up this volume: Life, Plants and Their Work, Insects and How They are Adapted to their Surroundings, Birds and Their Ways, Getting Acquainted with the Fishes.

Book IV. *Our Earth and Its Life.* 280 pages. The following units make up this volume: Our

Universe, The Building of the Earth, Life Begins on the Earth, Life Became More Complex, Our Present-day Amphibians, Our Present-day Reptiles, Our Present-day Mammals.
—W.G.W.

BRAGDON, LILLIAN J. *Tell Me the Time, Please.* New York: Frederick A. Stokes and Company, 1936. 100 p. $1.25.

This book tells in simple language and appropriate pictures the progress in telling time from man's first observations of night and day to our present-day clocks. It is suitable for fourth or fifth-grade reading. —W.G.W.

DUNCAN, F. MARTIN, and DUNCAN, L. T. *The Wonders of Nature Series.* (24 vols.) New York: Oxford University Press, 1930–1935. $0.35 each.

This series of books cover the following four general topics:

Wonders of the Sea, consisting of these individual books: *Wonders of the Shore; The Lobster and His Relations; The Starfish and His Relations; Dwellers in the Rock-Pools; Life in the Deep Sea; The Sea-Birds.*

Wonders of Insect Life, including the following books: *Butterflies and Moths; Bees, Wasps and Ants; Beetles and Flies; In Pond and Stream; Some Curious Insects; Spiders and Scorpions.*

Wonders of Plant Life, including the following books: *The Story of the Plants; Plants and Their Children; Land and Water Plants; Plant Traps and Decoys; Some Curious Plants; Plant Friends and Foes.*

Wonders of Animal Life, including the following books: *Animal Life in the British Isles; Animal Life in Africa; Animal Life in the East; Animal Friends; Bird Land; Animal Life in the New World.*

These books describe in a general way plant and animal life in simple, chatty style for reading in English elementary schools. In no sense field guides with reference to particular regions, much of the subject matter could be used in English-speaking schools anywhere. The style and the terms, however, are specifically English.

The books are attractively illustrated with many beautiful colored plates as well as with drawings and photographs. —L.M.S.

BIDDLE, HARRY C., AND BUSH, GEORGE L. *Dynamic Chemistry.* Chicago: Rand McNally and Company, 1936. 820 p. $1.80.

These authors believe in the following guiding principles for a text: "1. To give the student a knowledge of chemistry adequate to the academic or vocational needs of the student; 2. To help the student develop a scientific attitude that will carry over with all fields of thinking; 3. To give him an understanding and appreciation of the relation of chemistry to other subjects and to the world about him."

This text includes the ordinary subject matter for the "standard" course and in addition "material needed to satisfy the broad purposes of life."

The book is divided into 12 units. Each unit is subdivided into from three to five problems. Each unit opens with a preview, and following the problems are "self-checking questions" and several pages of "suggested activities." These are helpful for review. A bibliography of references ends the unit. There is a 12-page glossary. The book is well illustrated, interestingly written, uses modern theory, strong on practical applications and its 820 pages will give most high-school pupils all they can do in a year.
—W.G.W.

FISK, DOROTHY M. *Modern Alchemy.* New York: D. Appleton-Century Company, 1936. 171 p. $1.75.

Modern Alchemy, in nine chapters, gives an interesting account of the development of theories of the divisibility of matter from the atomic theory of the old Hindu philosophy, through Aristotle's structureless theory, back to the atoms of Boyle and Dalton and on to the electron theory of today.

The book gives a particularly clear and understandable story of our new knowledge of the different particles that make up the atoms and of their relations to each other. The absence of technicalities and mathematics makes the book valuable for high-school reference. It contains appropriate illustrations. —W.G.W.

NOYES, WILLIAM ALBERT, AND NOYES, W. ALBERT. *Modern Alchemy.* Springfield, Illinois: Charles C. Thomas, 1932. 207 p. $2.00.

This is a brief survey of modern chemistry. It is a very readable book and most of it could be profitably read by the high-school chemistry student. The chapters on atomic structure, valence, transmutation of the elements and new elements are about as readable as one will find any place. The accuracy of the work is assured, as the authors are outstanding chemists—the senior author a chemist at Illinois University and his son at Brown University. —C.M.P.

LEWIS, HOWARD B., AND MILLER, LILA. *Experiments in Chemistry.* Ann Arbor, Mich; Edward Brothers, Inc., 1936. 67 p. $1.50.

This is a laboratory manual used in the School of Nursing of the University of Michigan. Many of the experiments could be very appropriately used in high-school chemistry. —C.M.P.

MERSEREAU, SAMUEL FOSTER. *Materials of Industry.* New York: McGraw-Hill Book Company, 1936. 541 p. $2.00.

This book is intended for use in vocational, technical or industrial secondary schools. It can also be used as an excellent supplementary book in high-school science classes. The author

is an instructor in the Brooklyn Technical School. Excellent glossaries and summaries supplement each chapter, together with a list of practical questions, pertinent diagrams, illustrations and photographs. Most of the common materials of industry are covered, such as various metals, forest products, rubber, paint, glass, brick and lime. —C.M.P.

BRAY, FRANK CHAPIN. *The World of Myths.* New York: Thomas Y. Crowell Company, 1935. 32 3p. $2.00.

This is a compilation of the chief myths of the various regions of the world, arranged in concise, alphabetical order according to each region. No great space is given to any divinity, but the aim of the author was to make it a "who's who in mankind's mythology." Needless to say many of the myths have a pseudo-scientific background. The book serves to recall many myths that were formerly familiar, but now are somewhat vague. —C.M.P.

Symposium. *Science and the Young Child.* Washington: Association for Childhood Study, 1936. 40 p. $0.35.

All elementary science and nature study teachers will find this pamphlet interesting and useful, although they may disagree with much that is said. To the reviewer it seemed to smack too much of nature study and not enough of elementary science.

The sections on "Suggested List of Science Activities for Young Children and Science Equipment and Supplies" failed to live up to their promise and seem especially weak. Other topics are: (1) "The Teacher Listens to the Science Specialists"; (2) "The Place of Science in the Nursery School"; (3) "Science in the Kindergarten"; (4) "Physical Science in the Elementary School"; (5) "Making the Most of a Meager Environment"; (6) "Relating Science to the Child's World"; (7) Books Useful in Nature Study and Elementary Science," and (8) "Western Nature Study Books." —C.M.P.

WRIGHTSTONE, J. WAYNE. *Appraisal of Experimental High School Practices.* New York: Bureau of Publications, Teachers College, Columbia University, 1936. 194 p. $2.25.

Progressive educators recognize that a significant and far-reaching reconstruction of secondary education has just begun. Major changes are being made in administration in methods, and in courses offered. Part I describes the trends, philosophies, psychologies, and contrasting curricula—old and new—of representative conventional and experimental high schools. Part II presents and interprets an inclusive appraisal of the old, versus the new, practices.

In experimental high schools the trend is to include more science and to integrate all the sciences, integrating mathematics with the science. In every test given in science, the experimental schools came out ahead. These tests included recall of facts in general science, recall of facts in biology, recall of facts in chemistry, recall of facts in physics, working skills, interpreting facts, applying generalizations, and science beliefs. In the appraisal of performance factors, conventional high schools led in recitational activities and experimental high schools led in self-initiated activities. This one-sidedness in testing results might make one somewhat skeptical as to the adequacy of the testing devices used or the operation of some determining factors. An interchange of the two teaching personnels would very likely change results. But were this possible, it would not be quite fair. However, suppose the teachers of the experimental schools were to teach in conventional schools, might not some of the test score results be quite different? Wrightstone has made a valuable contribution in this book that ought to be a required reading of every secondary science teacher as a part of his keeping in step. —C.M.P.

BROWN, ROBERT M., AND THORP, MARY TUCKER. *Directed Geography Study, Book III.* Yonkers, N. Y.: World Book Company, 1934. 124 p. $0.52.

This is a geography workbook based on the unit "World Interdependence," emphasizing the United States and some typical interdependent countries. The latter include Great Britain, Africa, Japan, China, the A B C countries, the Amazon Basin and the Arctic and Antarctic Regions, and the Caribbean Region. The workbook may be used as supplementary material with any textbooks. For those desiring to use workbooks in connection with their geography work, this book is recommended. —C.M.P.

ATWOOD, WALLACE W. *The United States Among the Nations,* 1930. 262 p. $1.32; *The World At Work,* 1931. 344 p. $1.60. Boston: Ginn and Company.

These two geography textbooks are worthy additions to the many excellent geography textbooks now available. In content and illustrations they are all that is to be desired. The maps add very much to the usefulness of the books. Doctor Wallace is one of the most outstanding of American geographers and the author of numerous geographical articles and textbooks. —C.M.P.

FINCH, GRANT E. *New England.* New York: Rand, McNally and Company, 1933. 154 p. $0.96.

This is a geography textbook on the most homogeneous region in the United States. Historical, social, political and economic factors have been correlated with the geography, much to the enrichment of the latter. The book is organiged on the unit plan. The general theme is the adjustment of man to his environment. Many excellent photographs add to the attractiveness of the book. At the end of the book each of the

states is treated separately. It is regrettable that we do not have similar treatises of other regions of the United States. —C.M.P.

SMITH, J. RUSSELL. *Our Country and Northern Neighbors.* 330 p. $1.32; *Our European Neighbors.* 246 p. $1.12; *Other World Neighbors.* 311 p. $1.32; *Our Industrial World.* 290 p. $1.80. Philadelphia: The John C. Winston Company, 1934.

This series of geography textbooks are for grades five, six, seven and eight respectively. Altogether they form one of the very best geography sequences that have been written to date. The reading matter is presented in a vivid, colorful style that appeals to the reader, holding his attention and interest. They are written in the accepted unit technique and are most excellently illustrated. In mechanical make-up they present a most pleasing appearance. Doctor Smith, the author, is one of the most outstanding geographers in this country, a noted traveler and unexcelled as a writer of geographical material. —C.M.P.

BURTON, HARRY E. *The Discovery of the Ancient World.* Cambridge, Mass.: Harvard University Press, 1932. 130 p. $1.50.

In this popularly written volume, which is of unusual interest to the general reader as well as to geographers, the author traces chronologically the gradual extension of geographical knowledge in antiquity until the time of Ptolemy. The author accords much more importance to the contributions of the Cretans and also to Alexander the Great than is usually assumed. Among the great contributors to our present knowledge of discovery in the ancient world may be mentioned Herodotus, Eratosthenes, Alexander the Great, Strabo, Pliny, and Ptolemy. The book is highly recommended to those desiring a knowledge of the advances made in the geographical knowledge of man up to the time of Ptolemy. —C.M.P.

DICKINSON, R. E., AND HOWARTH, O. J. R. *The Making of Geography.* New York: Oxford University Press, 1933. 264 p. $2.50.

This is a history of the growth of man's knowledge about the earth from the first surmises of the Sumerians, Egyptians and Greeks to the most modern developments of physical and human geography. It is a record of the scientific knowledge that has been gained as a result of explorations of the last three thousand years. This is a book to be recommended to the general reader, geographers, and general-science teachers. —C.M.P.

MORRIS, FREDERICK K. *The Making of the Valley.* New York: Thomas Nelson and Sons, 1936. 75 p. $0.50.

This is one of *Our Changing World* series of teaching units developed in the Horace Mann Elementary School of Teachers College, Columbia University. This particular book tells the story of the geological history of the Hudson River. The Hudson River region has had a thrillingly interesting history. The book is very cleverly done and should serve excellently as a supplementary reader for general-science pupils (and even elementary science and general-science teachers). It is a most readable book and is scientifically accurate. —C.M.P.

SCHUCHERT, CHARLES, AND DUNBAR, CARL O. *A Textbook of Geology, Part II: Historical Geology.* New York: John Wiley and Sons, Inc., 1933. 551 p.

This is the third edition of a textbook first appearing in 1915. The popularity of the earlier texts should be enhanced by this new edition which has been completely revised, rearranged and made less technical. The book is intended as a part of the introduction course in college geology and is recommended to all readers who are interested in reading an authoritative treatise on the history of the earth. There are many interesting pictures and diagrams and the style is commendable. —C.M.P.

BENGSTON, NELS A., AND VAN ROYEN, WILLEM. *Fundamentals of Economic Geography.* New York: Prentice-Hall, Inc., 1935. 802 p. $5.00.

This text is designed to furnish the subject matter for an introductory course in college geography. Causal influences are emphasized and industrial processes are not emphasized as such, but rather the causes of distribution of industrial activities and the significance of resulting production. Needless to say much of the discussion has a scientific background and science teachers will find it an excellent reference on many topics, *e.g.*, water-power, coal, petroleum, iron, climate, and plants. The reviewer believes it is the best text of its kind now available. —C.M.P.

BERGSMARK, DANIEL R. *Economic Geography of Asia.* New York: Prentice-Hall, Inc., 1935. 618 p. $3.50.

Economic Geography of Asia is a book that fills a desired need, for there has been a dearth of books on the geography of Asia. Other continents have been fairly adequately treated, but not so Asia. The author has accomplished a difficult task creditably. The information has been painstakingly checked for accuracy and the style is quite readable. A reading of this book adds to one's cultural knowledge of the world.

—C.M.P.

SMITH, HARRIET, AND MITCHELL, ADELPHIA. *Some Helps in the Teaching of Geography.* Huntsville, Texas: Department of Public Service, Sam Houston State Teachers College, 1935. 22 p. $0.15.

This is a very useful bibliography. Divisions are as follows: "Maps, Atlases and Globes"; "Lantern Slides, Pictures and Periodicals"; "Government Publications"; "Books on Methods of Teaching Geography"; "Teacher References on

Subject Matter"; "Geography Texts for Grades"; "Supplementary Reading for the Grades"; "Travel Booklets," and "Sources of Free Material."

—C.M.P.

PARKINS, A. E., AND WHITAKER, J. R. (Editors). *Our Natural Resources and Their Conservation.* New York: John Wiley and Sons, Inc., 1936. 650 p. $4.00.

This book discusses problems that every American should be vitally interested in. Special chapters have been written by authorities in that particular field. Contributors are: Wallace W. Atwood, O. E. Baker, Nels Bengston, H. H. Bennett, Ralph Brown, Robert M. Brown, Loyal Durand, W. H. Haas, Elsworth Huntington, George J. Miller, A. E. Parkins, Edward T. Prophet, George T. Renner, V. E. Shelford, Guy-Harold Smith, J. Russell Smith, Helen M. Strong, S. S. Visher, J. R. Whitaker, Frank Williams and Louis Wolfanger. Topics discussed include soils, tree crops, arid lands, swamp lands, forests, waterpower, flood control, mineral resources, wildlife, recreational resources, and human life. It is an excellent reference book both in science and in geography. —C.M.P.

WEED, HENRY T., REXFORD, FRANK A., AND CARROLL, FRANKLIN B. *Useful Science for High School.* Philadelphia: The John C. Winston Company, 1935. 707 p. $1.68.

This is a general-science textbook. It excels in certain things: excellent photographs and illustrations, and the list of numerous experiments. There are 182 experiments, mostly at the end of chapters "to prevent breaking the continuity of the reading matter." The experiments make this an excellent supplementary reference for use with other textbooks. This emphasis on experiments has necessitated certain sacrifices, at too great a price some would say. Yet it is useful to have a book of this sort available. —C.M.P.

BLACK, NEWTON H. *An Introductory Course in College Physics.* New York: The Macmillan Company, 1935. 714 p. $3.50.

This is a first-year college text in physics, "written especially for those college students who have never studied physics or who find that their preparation is inadequate for the more advanced textbooks." The mathematical aspects are not emphasized, and concrete illustrations and experiments are used to introduce abstract concepts.

Undoubtedly the book will have the wide and extensive usage that it merits. The author is a well-known physicist of Harvard University.

—C.M.P.

BENNETT, H. (Editor). *The Chemical Formulary.* New York: D. Van Nostrand Company, 1933. 604 p. $6.00

The Chemical Formulary contains 4,900 practical formulas compiled by a group of practical chemists. Almost every subject imaginable is covered. Definite, specific directions are given for the making of the new products, namely, what chemicals to use, how much of each is required, and how to mix them for best results. All science teachers and more especially chemistry teachers will find this a most useful book. —C.M.P.

Symposium. *The Home Chemist.* New York: Grosset and Dunlap, 1934. 192 p. $1.00.

This is one of a series of books on practical science prepared by the editorial staff of *Popular Science Monthly.* It tells how to set up and operate a hame laboratory and gives full directions for numerous novel experiments both practical and for fun. These experiments make the book a valuable addition to the high-school science shelf. It would serve as a valuable adjunct to the work of the Science Club. Chapter headings are: "Setting Up a Home Chemical Laboratory"; "Chemical Fun with Metals"; "Fun with Gases"; "Simple Experiments in Physical Chemistry"; "Electro-Chemical Experiments"; "Simple Chemical Tests"; "Chemical Tricks and Chemical Magic"; "Home Laboratory Stunts," and "Practical Uses for Your Home Laboratory."

—C.M.P.

ATKINS, WESLEY C. *Some Probable Outcomes of Partial Self-Direction in Tenth-Grade Biology.* Published by the author, Trenton, N. J. (401 Cuyler Ave.). 101 p. $1.25.

This is a dissertation submitted in partial fulfillment of the requirements for the doctorate degree at Columbia University. In the self-directed groups the method was as follows. Some topic like the grasshopper or the earthworm was announced by the teacher. "From ten to thirty minutes were spent by teacher and class in a joint exploration of the possibilities of the topic for class and individual project studies." Pupils handed in a written outline of the problem which each wished to undertake. These were examined by the teacher who suggested alterations if needed. Pupils were given time and opportunity to work in laboratory, library, parks or elsewhere. Pupils then came together and (a) each one gave a written report of his work or (b) the teacher led in a topical summary of the class findings. The author conducted four classes, each for a semester by this method and four control classes by the usual laboratory method in the Jefferson, New Jersey, High School for boys. Two other teachers cooperated, one teaching two experimental and two control classes, the other one each, in the girls' high school. The self-direction method does not result in the acquisition of more factual knowledge. It does result, the author thinks, in keener interest, more painstaking effort and a more scientific attitude. The evidence for this is however subjective—the opinions of the teachers and of the judges who examined the notebooks. The whole study, both in inception and execution, seems rather futile. —E.R.D.

SHERMAN, HENRY C. *Food and Health.* New York: The Macmillan Company, 1934. 296 p. $2.50.

"The newer knowledge of nutrition has both clarified and advanced our conception of health." This volume helps one to apply this new knowledge to his own health betterment and to budget the food money more economically. A few of the chapter titles give a survey of the contents: "Importance of an Intelligent Use of Food"; "Energy for Our Daily Work"; "Foods as Fuels"; "Control of Body Weight"; "Digestion"; "Proteins and Animo Acids"; "The Mineral Elements"; "Born Calcium-Poor"; "Outstanding Concepts in Nutrition"; "The Vitamins"; "The Option Which Our Present Knowledge Offers."

An appendix gives tables of food values, records of meals and a selected bibliography.

—W.G.W.

SHERMAN, HENRY C. *Food Products.* New York: The Macmillan Company, 1935. 674 p. $3.00.

The earlier volume of this standard work on foods was entirely rewritten and enlarged for this third edition. It is a subject-matter book for the broad general study of foods and food products. It discusses food composition and values, production and control. All classes of foods are included and in addition food adjuncts such as spices, flavoring extracts, baking powders and beverages. One chapter is devoted to food economics. An especially fine index of 42 pages completes the book. —W.G.W.

SHERMAN, HENRY C. *Chemistry of Food and Nutrition.* New York: The Macmillan Co., 1936. 614 p. $3.00.

This is a rewritten and enlarged edition of what has been for over twenty years a basic text presenting the principles of the chemistry of food and nutrition. It incorporates the results of new research in the field. It takes up nutritional chemistry, energy requirements, metabolism, metal requirements and the one subject, vitamines, takes up 125 pages. Important statistical data and valuable references for supplementary reading are given. —W.G.W.

NEWMAN, HORATIO H. *Outlines of General Zoology.* New York: The Macmillan Company, 1936. 661 p. $3.50.

This college text is adapted to follow a general survey course in science given in the freshman year. The work is divided into six parts as follows: "Biological Science and Its History"; "General Biological Principles"; "Representative Animal Types (Invertebrates)"; "The Phylum Chordata"; "Biological Mechanisms"; "Mechanisms of Racial Maintenance and Adjustment (Evolution and Genetics)."

There are 277 illustrations and a valuable glossary of 36 pages. —W.G.W.

ROEHL, KATHERINE M., AND NEWMAN, H. H. *A Laboratory Manual for General Zoology.* New York: The Macmillan Company, 1936. 99 p. $1.00.

This book gives complete directions for laboratory work in general biology. It was prepared for use with *Outlines of General Biology* by Newman, but it may readily be used with other texts. This manual attempts to incorporate the desirable features of both the "type" and the "principles" plan of study.

—W.G.W.

HEGNER, ROBERT W. *College Zoology.* New York: The Macmillan Company, 1936. 702 p. $3.50.

This is a revision of the previous edition in which the subject-matter has been brought up to date. Each chapter treats a phylum or class by describing a type organism, giving a brief discussion of classification, and a short discussion of the relations of the group to man. An introductory chapter of 29 pages gives a quick survey of biology as a science. The text is closed by a 25-page chapter on heredity and genetics, and a final summarzing chapter "Some Zoological Principles and Theories." —O. E. Underhill.

BAITSELL, G. A. *Manual of Biology.* New York: The Macmillan Company, 1936. 412 p. $2.50.

The text and laboratory manual are combined in one volume, 325 of the 412 pages being devoted to the textual material. The unit of organization is the organism. Each chapter, devoted to a type organism traces the functioning of the various systems in carrying out the various life processes. The plant materials is discussed under chapters on colorless plants, moss, fern, and seed plants. —O. E. Underhill.

WOODRUFF, LORANDE LOSS. *Foundations of Biology.* New York: The Macmillan Company, 1936. 583 p. $3.50.

This is the fifth edition of Woodruff's well-known college biology. As in previous editions this book presents a broad survey of the principles of biology.

Both the text and the illustrations have been thoroughly revised. The text in particular has been brought up to date in every respect. A new section which gives a synoptic view of the plant and animal kingdoms has been added. This section is placed in the final chapters of the volume in order not to break up the general continuity of the narative of the text.

—E.D.H.

PAGE, NEWELL C. *Lessons and Problems in Electricity.* New York: The Macmillan Company, 1936. 356 p. $2.75.

This is a textbook in pure electricity for the college students. Throughout the book considerable mathematics is used and a knowledge of

calculus is necessary for the working of the problems and for a fuller understanding of the text material. The author has organized his material with great care. As chapter headings the most important principles have been selected. The introduction of new terms is left to the place where its greatest application is discussed in the text. These definitions are very clear and a good deal of attention has been given to their wording so they are understandable and clear. A wide range of thought provoking problems are given at the end of each chapter. The diagrams are line diagrams for the most part, they are as simple as possible and are very easy to understand. This book has a very definite place as a text in beginning electricity courses or as a valuable reference to such courses.

—F. L. Herman.

CULVER, CHARLES A. *A Textbook of Physics.* New York: The Macmillan Company, 1936. 816 p. $4.00.

This new physics is written for the college student. It was first developed in the author's classroom teaching. It contains a wealth of physical data and material. While the necessary mathematics is included in the body of the book, this phase of the subject is avoided. This feature makes it especially adaptable to students who desire to receive an overview of physics without becoming involved in a lot of higher mathematics.

The arrangement of the material is somewhat of the traditional type. This would make a very good book for reference in both the college and the high school. The material is very well illustrated by many clear-cut diagrams and pictures.

—F. L. Herman.

JONES, H. SPENCER. *Worlds Without End.* New York: The Macmillan Company, 1935. 329 p. $3.00.

Worlds Without End is written in the more popular vein of astronomy. The foundations for the modern studies in astronomy are well laid by numerous historical developments. The progress of astronomy is well developed.

The author takes up the trends in modern telescope design which have made the recent discoveries in this field possible. The book is very well illustrated with many clear-cut photographs, there being thirty-two of them. Those interested in tracing through a theory of cosmic evolution will find this work very pleasing and of great assistance. This book makes delightful popular reading and still enough of theory is introduced to challenge the thinking of the reader. As a reference book this work will be found to be excellent, and it is suggested as a supplement to a more theoretical treatise in astronomy.

—F. L. Herman.

BAKER, ROBERT H. *An Introduction to Astronomy.* New York: D. Van Nostrand Company, Inc., 1935. 312 p. $3.00.

The new book by Baker is of the same general type as his previous but larger book on astronomy. This book is very much smaller than the previous work, and is intended for the shorter introductory courses in astronomy. "It undertakes to tell the story of the heavens in a way that will be understandable without special preparation."

The book deals with the earth and the sky, the nations of the earth, the stars, the planets, the sun, the solar system, nebulae, and beyond the milky way. As is usual with the author's previous works, it contains many clear diagrams and pictures. For the most part these are excellent. To these have been added some excellent star maps according to seasons, thus aiding the student in locating these features in the heavens. The explanations and descriptions in the text are given with the author's usual clarity.

—F. L. Herman.

BRANSON, E. B., AND TARR, W. A. *Introduction to Geology.* New York: McGraw-Hill, 1935. 470 p. $3.75.

This is a text for first-year college students in geology. It is intended to fit the need for a one semester course for five hours' credit. The book is in two parts. The first deals with physical geology and the second with historical geology.

The authors have caught the vision of the need for science training of the general college student who in all probability will never specialize in any science. There is no attempt to cover every phase of geology in this first course. Instead the authors have emphasized the outstanding principles of the subject and selected illustrative materials to make these principles understandable. Technical terminology is minimized.

The book is readable, as most college science textbooks are not. Illustrations are interesting and well chosen. Many of them are photographs taken by the authors.

The book is recommended for serious consideration to all teachers of college geology. It is also recommended to the lay reader who may wish to widen his acquaintance with the planet upon which we live. High-school science teachers looking for an understandable reference book on geology for the high-school library may well add this text to the library list. —R.K.W.

SINNOTT, EDMUND W. *Botany, Principles and Problems.* New York: McGraw-Hill Book Company, Inc., 1935. 525 p. $3.50.

This is a textbook in general college botany. The content, in the main, is organized like that of most college botanies. Chapters I to VI are devoted, for the most part, to a discussion of the structure and function of cells, roots, leaves, and stems. Chapters VII to XIII deal with such topics as metabolism, growth, morphogenesis, reproduction, heredity, variation, and plant evolution. Chapter IX, which deals with morphogenesis (experimental morphology), is unique for a general college botany. Chapters XIV to Chap-

ter XXIII present a detailed account of all the plant phyla.

The most radical change in this textbook is found in the classification of the vascular plants. To quote the author: "As commonly presented in elementary courses this subject has for some time been in need of a thorough revision. The remarkable discoveries of recent years with regard to the character of the earliest known land plants, the Psilophytales of the Devonian, have provided us with a basis from which to derive the three main lines of vascular plants which are now so clearly distinguishable, and which for some time have been designated as the Lycopsida, the Sphenopsida, and the Pteropsida. The evolution of the modern seed-bearing plants, the Gymnosperms and the Angiosperms—from the last of the three is universally admitted, but the name Spermatophytes for these plants is evidently a misnomer, since the seed-bearing habit has certainly arisen a number of times and in other groups. The time honored terms Pteridophyta and Spermatophyta and the groupings which these designate have therefore been discarded in favor of a more natural classification and a more appropriate nomenclature. For the vascular plants as a whole the term Tracheophyta is here proposed, as cognate with Thallophyta and Bryophyta."

—E.D.H.

MILLS, CLARENCE A. *Living With the Weather.* Cincinnati: The Caxton Press, 1934. 206 p. $1.50.

The author is an ardent devotee of Ellsworth Huntington and thus it is not surprising that the theme of the book assigns all our ills and gains to the vagaries of weather and climate. "There can be little doubt that man's energy level is affected by the stimulating drive of his atmospheric environment and that it is these factors of climate or weather which largely determine his advance or decline, his vigor or debility, his fertility or sterility, both mental and bodily —— not only have slow changes in climate matched the rise and fall of civilizations" but we are affected tremendously by the daily changes in weather conditions. The book is very readable and many of the author's statements are based on his observations as a practicing physician. He greatly decries the excessive use of coffee by Americans, saying its physiological effect is almost as harmful as that of alcohol. "We as well as economic cycles behave as we do because of the weather."

—C.M.P.

PLANCK, MAX. *The Philosophy of Physics.* New York: W. W. Norton and Company, 1936. 128 p. $2.00.

Four brief essays on philosophical topics suggested to a physicist by his familiar subject. "Physics and World Philosophy" undertakes to show "the connection between physics and the endeavor to attain a general philosophy of the world." The closely reasoned condensed arguments of this and the following essays admit of no summaries. They are themselves outlines and one must fill in between the lines for the author takes long steps. A few excerpts may give a taste of the quality. The following is quoted from the final paragraph of I. "There is . . . a secure possession . . . ; an inalienable treasure . . . a pure mind and good will. . . . They are the essential of every genuine science. . . ."

Essay Number II is on "Causality in Nature." "In my opinion there is not the slightest contradiction between the domination of a strict causality in the sense here adopted and the freedom of the human will." (p. 79)

The third essay is entitled "Scientific Ideas." "The truth or falsity of an idea and the question whether it has a definite meaning is relatively unimportant; what matters is that it shall give rise to useful work." (p. 116)

"Science and Faith" is the title of the last essay. "And associations of ideas are not the work of the understanding but the offspring of the investigator's imagination—an activity that may be described as faith, or, more cautiously, as a working hypothesis.

—E.R.D.

STRAYER, GEORGE D., FRASIER, GEORGE W., AND ARMENTROUT, WINFIELD D. *Principles of Teaching.* New York: American Book Co., 1936. 295 p. $2.00.

This is a very readable and practical book that will be welcomed as a guide by the young teacher and may knock some older ones out of their ruts if they are not already too deeply mired. It is not a discussion of abstract principles but a fresh and vigorous application of the results of modern investigations to teaching situations. These are characteristic chapter titles: "Teaching to Fix Facts and Form Habits," "Teaching to Develop Thinking," "Teaching for Character Development." The style is clear and simple, the vocabulary non-technical. There is a well selected bibliography.

—E.R.D.

KILPATRICK, WILLIAM H. *Remaking the Curriculum.* New York: Newson & Co., 1936. 128 p. $0.80.

Briefly the author's point of view may be stated somewhat as follows. We live in a rapidly changing social order. Education recognizes that one builds his growing self by facing real life situations and assuming responsibility for their solution. The curriculum must be made up of project-activities, like writing a play or building a camp fire, not of subjects like arithmetic and spelling. "The curriculum procedure herein contemplated is a succession of pupil-pursued activities chosen and directed—at least predominantly—by the class-and-teacher group." The old curriculum set out subject matter to be learned in order to hand down a social order with which we were well satisfied. The new life process curriculum stimulates pupils to question the old order and intelligently adjust themselves to the new.

—E.R.D.

HILLIARD, CURTIS M. *A Textbook of Bacteriology and Its Applications.* Boston: Ginn and Company, 1936. 339 p. $3.50.

This book is so interesting and so informative that it may well be read by the layman as well as by students beginning bacteriology. To the latter individuals it will be a joy to find a text so thorough and convincing in its presentation of facts, so lucid in its discussions, and so exact in its descriptions of techniques.

Specific laboratory directions for preparation of culture media, tests for particular bacteria, etc., occupy the last 30 pages of the book. It would improve it to use the same size of type here as in the body of the text. Some tables in the body of the text, the keys and explanations of figures are also in type that will strain even young eyes in the light of many laboratories. Errors are rare. The reference on page 92 to the table on page 84 should be to page 88. Some items are omitted from the index; cellulose, for instance, does not appear, though it is mentioned on pages 123, 133, *etcetera.*

On the whole the choice of the material selected for presentation seems wise and quite adequate for a beginner's course. —E.R.D.

THORNDIKE, EDWARD L., AND ASSOCIATES. *The Psychology of Wants, Interests and Attitudes.* New York: D. Appleton-Century Co., 1935. 301 p. $3.50.

The drive or urge to our actions lies mainly in our wants, interests and attitudes. To establish the desirable ones and eradicate or at least weaken the undesirable is one of the major aims in education in the home, school and other training agencies both of the child and the adult. Are these motivating emotional factors acquired consciously always or may they be established or altered without the subject being aware of it? Are rewards more effective in developing desirable wants and interests than are punishments in suppressing the undesirable ones? How large do rewards have to be in order to be effective? If I have to hire a child to read Stevenson's books instead of the lurid junk displayed on the magazine racks of the local shops, what are the chances of finally developing a taste for good literature? These are the sorts of questions answers for which are sought in the data derived from the many experiments described in detail in this volume. The bulk of the book is devoted to these experimental details. But the conclusions and their practiacl applications make interesting and profitable reading for teachers and parents even though the book is of primary value to the psychologist. —E.R.D.

MAVOR, JAMES W., AND CLARK, LEONARD B. *A Laboratory Manual in General Biology.* New York: The Macmillan Co., 1936. 201 p. $1.75.

The book deals largely with morphology of the plants and animals. To save the students' time outline drawings are printed; the details of parts can be filled in. It evidently belongs with a course the main theme of which is evolution and the evidence taxonomic. —E.R.D.

MAVOR, JAMES WATT. *General Biology.* New York: The Macmillan Company, 1936. 729 p. $4.00.

This is a college biology textbook. The author states that in writing this book the aim has been "to state simply and clearly the main facts and principles on which a sound and teachable course in biology can be based."

Leaders in the field of science education rather generally believe that a course in general biology should be organized around the principles and major generalizations of biology. An examination of the contents of this book reveals again how difficult it is for authors of biology textbooks to get away from the old tripartite arrangement; this is a section about plants, a section about animals, and a section on physiology.

This book is divided into five main parts. Part I treats of the scope of biology, cell structure, protoplasm and the cell principle. Part II presents a detailed overview of the plant kingdom. Part III deals with invertebrate animals. Part IV treats of vertebrate animals. Part V, titled "Principles," deals in the main with the topics of embryology, heredity, adaptation and evolution.

The text is clearly written and well illustrated. —E.D.H.

MELDRUM, WILLIAM BUELL, AND GUCKER, JR., FRANK THOMSON. *Introduction to Theoretical Chemistry.* New York: American Book Company, 1936. 614 p. $3.50.

This book is one of the best comprehensive surveys of the field of general chemistry that this reviewer has seen for many years. The entire book is very well balanced as regards the extent and the quality of the material covered in the various phases of general chemistry subject matter. Unlike the majority of books dealing with theoretical chemistry, it is not filled with mathematics and the derivation of equations.

Wherever equations of chemical reactions are shown, the balancing of these equations is very well shown. The charges carried by the various ions involved in chemical reactions and the shift of charges during the reaction are very clearly shown. The book contains well chosen illustrations where they will serve to clarify the content at that point.

The book is recommended as an excellent text for courses dealing with the survey of the field of chemistry after the completion of the various courses in chemistry. Such courses have been adopted by many schools to bring unity to the various branches of chemistry. The book will also be an excellent text in a course in theoretical chemistry. —F. L. Herman.

BRADT, W. E. *Study Units in General Chemistry.* New York: D. Appleton-Century Company, 1936. 178 p. $1.50.

This is a laboratory book for college general chemistry. It has blank pages for student notes. It duplicates some of the simpler work that is commonly done in high-school chemistry but continues with each topic to a level of collegiate accomplishment. Concise directions for experiments accompany each unit; also a list of references and optional references are given. The experiments include preparations and some qualitative and quantitative work. Each of the twenty units is closed with an exercise consisting of questions and problems and a list of topics for review.

—W.G.W.

JOHNSON, JR., THOMAS CARY. *Scientific Interests in the Old South.* New York: D. Appleton-Century Company, 1936. 217 p. $2.50.

The author in this book rather successfully refutes the ideas presented by some historians that the Old South had little intellectual activity and no vital interest in natural science, but was more concerned with "the cultivation of cotton and the neglect of men." There is ample evidence given in the book to prove that science was taught in southern colleges, seminaries, and schools and that the average people were awake to the value and significance of science. The book represents a tremendous amount of painstaking work which has been well done. —W.G.W.

REISER, OLIVER L. *Philosophy and the Concepts of Modern Science.* New York: Macmillan, 1935. 323 p. $3.50.

This book is an attempt to state a philosophy which will take into account the findings of natural science. The author believes that the chaos in present economic and social life is largely due to a failure to formulate a guiding philosophy for the control of social phenomena which takes into account the developments in the sciences.

The basis for the philosophy is centered about the notion that energy is the essential stuff of the universe and that development must go in the direction of possible control of energy. The notion that many manifestations of energy seem irreversible is also a major thesis in the stated philosophy. The author insists upon a consideration of large patterns of phenomena rather than the study of the microscopic detail of particular phenomena as necessary for the formulation of a philosophy consistent with the findings of science.

Part I of the volume is concerned with the attempt to formulate a philosophy which will reconcile the findings of our present science. Part II deals with the implications in the living of human beings. The final chapter even goes so far as to outline what amounts to a political platform for social progress based upon the implications of the philosophy proposed.

The reader need not agree with the ultimate proposals of the author, but he should be enormously stimulated in his thinking if he is at all concerned with present intellectual conflicts.

—R.K.W.

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